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# FOOD FORM FUNCTION

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SYRACUSE UNIVERSITY SCHOOL OF ARCHITECTURE | SENIOR THESIS | TRAVIS J. TELEMAQUE | ADVISOR : TAREK RAKHA



FOOD FORM FUNCTION

# ACKNOWLEDGEMENTS

This book is dedicated to my loving parents who made it possible for me to attend Syracuse University School of Architecture. Dad, thank you for showing me how to work extremely hard and focus on every detail of a project. Mom, thank you for always being there to support me and picking up the phone at three in the morning for last minute advice. I love you both.

Additionally, I would like to thank my thesis advisor Tarek Rakha for helping me every week throughout my senior year. This project would not have evolved to what it is now if you didn't help. Not only were you my mentor and advisor, but you became a great friend. Thank you for everything you did to get me to this point.

Lastly, I would like to thank my girlfriend Margaux for her support and creative solutions. You pushed me everyday to believe in myself and my designs. You are the best architectural sidekick anyone could ask for, I love you.



# ABSTRACT

Urban agriculture is the alteration of landscapes, urban spaces, infrastructures, and architectures. Additionally, it can act as a social movement for sustainable developments, where organic farmers, local growers, and 'foodies' form networks created from a shared ideology regarding nature, community holism, and sustainable design. In order to maintain our global economy and produce food we rely heavily on natural resources including fertile soil, water, and energy. Years of unsustainable practice have lead to the degradation of these resources.

Food production for the ever-increasing global population can no longer be sustained through traditional farming techniques. Additionally, the use of pesticides, and chemical fertilizers all negatively impact our environment. If we do not possess the capacity to sustain soil-based farms, where will our food come from? The answer lies in our cities where we have the potential to practice sustainable urban agriculture. This study aims to evaluate how architecture and urban agriculture can be used to reconnect people with locally source food in a sustainable way. Questioning the possibility of feeding millions of people with urban vertical farms.

This study suggests that solar design strategies can influence a more sustainable approach to food production, focusing on New York City to determine a potential site in which an urban farm can be integrated. Specific case studies are presented to determine whether urban agriculture can be developed in an economical and sustainable manner. Additionally, several factors were analyzed including solar exposure, renewable resources, site accessibility, and development potential. This prototype urban farm will expose people to three categories of food production; controlled environment agriculture, productive vegetated facades, and rooftop agriculture.

Integrating food production into dense urban areas can reconnect us with food and create more resilient cities. By establishing a sustainable prototype urban farm there is great potential for these structures to germinate across cities. I conclude that building technology and design can adapt to feed the increasing urban populace.



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# CLAIM | CONTENTION

By 2050, the global population will have grown to over 9.7 Billion people. Traditional farming practices will no longer be able to sustain food production for the increasing population.

This thesis demonstrates how architecture and urban food production can be used to educate and reconnect our cities with locally sourced food. Intergrating food production into dense urban settings will create a more efficient and resilient city.

## AIMS

- 1 Propose a prototype live | work urban farm that provides food, jobs, housing, and urban agricultural education.
- 2 Propose a design that gets implemented at a specific urban development site within the city. Developers and city agencies can work together to provide local food sourcing for residents living in large urban developments.
- 3 Purpose a net-zero building that generates as much energy as it consumes and recycles as much waste as it produces.
- 4 Integrate a productive vegetated facade system that provides food directly to residential units.



# CHAPTER 1 | INTRODUCTION



*“Today’s cities fail to meet even the minimum standards of self-reliance. No city lives within its own means. Everything consumed is produced outside the city, and as a result, waste accumulates at an alarming rate”*

*The Vertical Farm - Dr. Dickson Despommier*

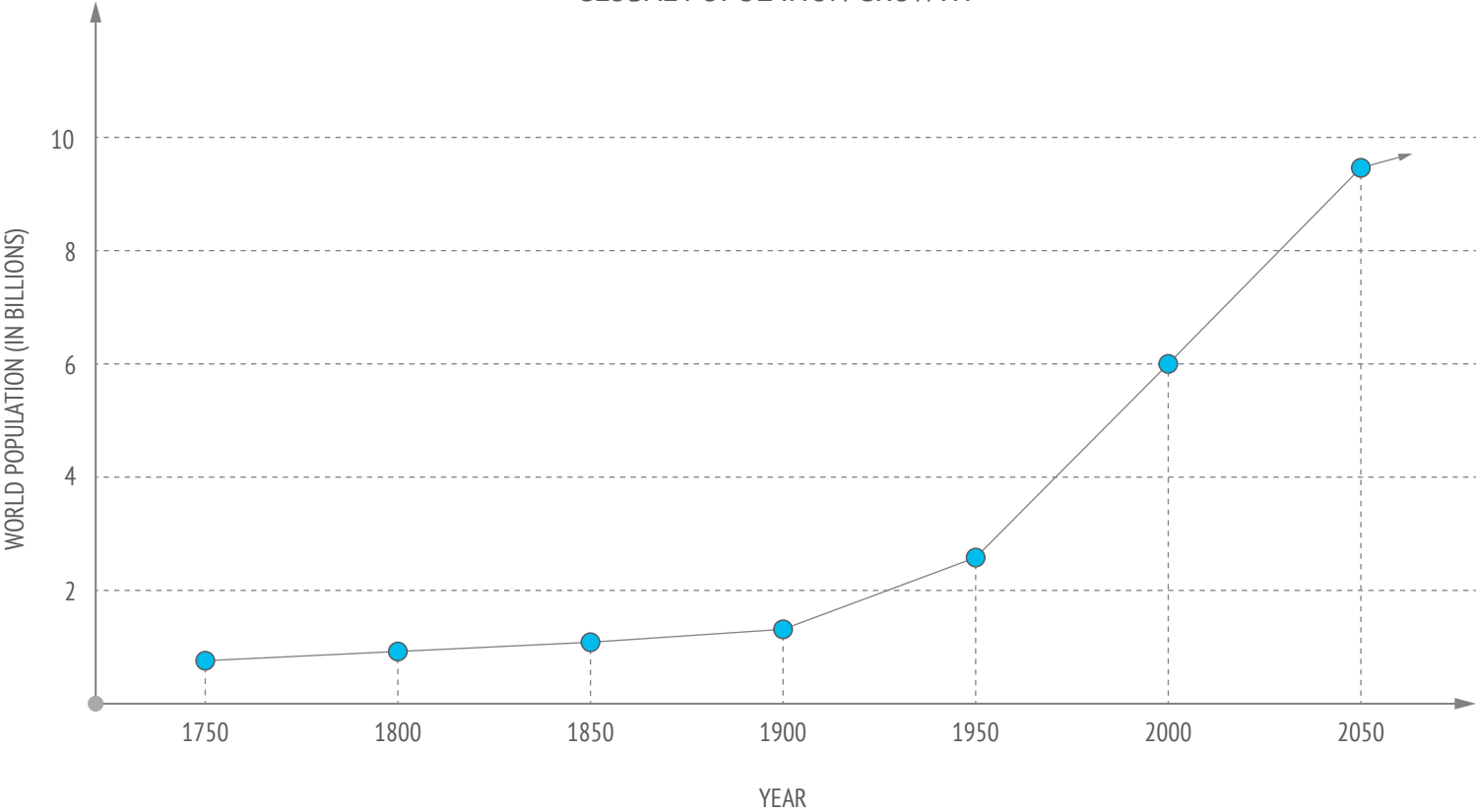
*“Developing agricultural capacity within or close to urban areas such as New York City (NYC) has the potential to reduce transportation costs and environmental impacts, provide economic development opportunities, and increase access to healthful food”*

*Sustainable Urban Agriculture - NYSERDA*

# CURRENT FARMING METHODS

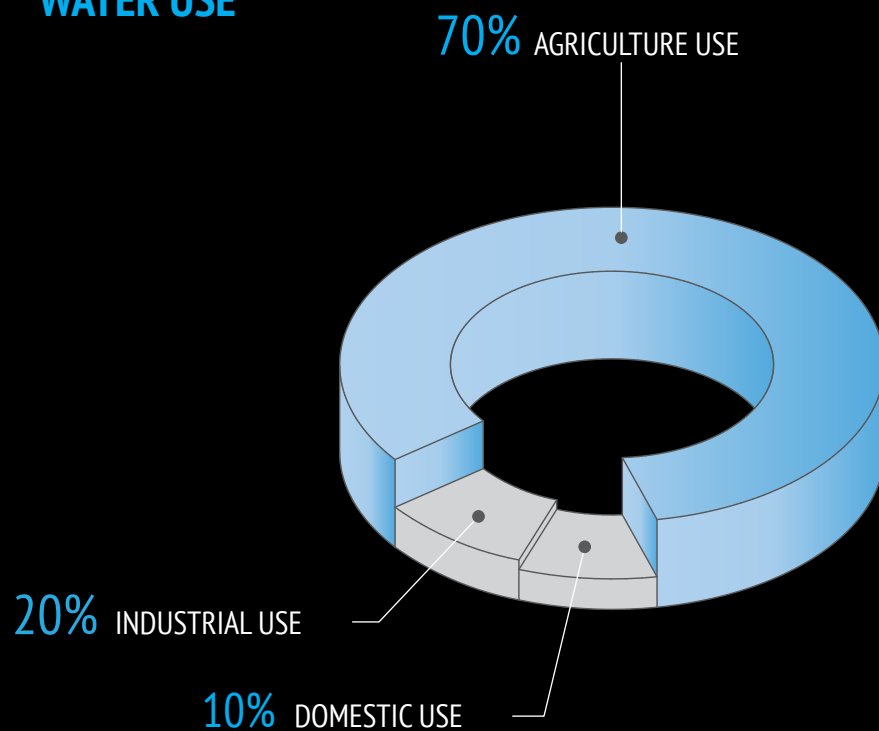
Agriculture is one of the most important industries needed to maintain a functional society. As the global population increases the demand for fresh fruits, vegetables, and grains will increase. Current farming methods will not be able to sustain production for the increasing population. Additionally, agriculture within the United States consumes 70% of water use and 30% of energy use. Land availability is also being impacted as we currently farm a landmass equivalent to the size of South America. By 2050 it is expected that we will need the landmass of South America plus Brazil. It is crucial that we research and develop alternatives to current farming methods.

GLOBAL POPULATION GROWTH

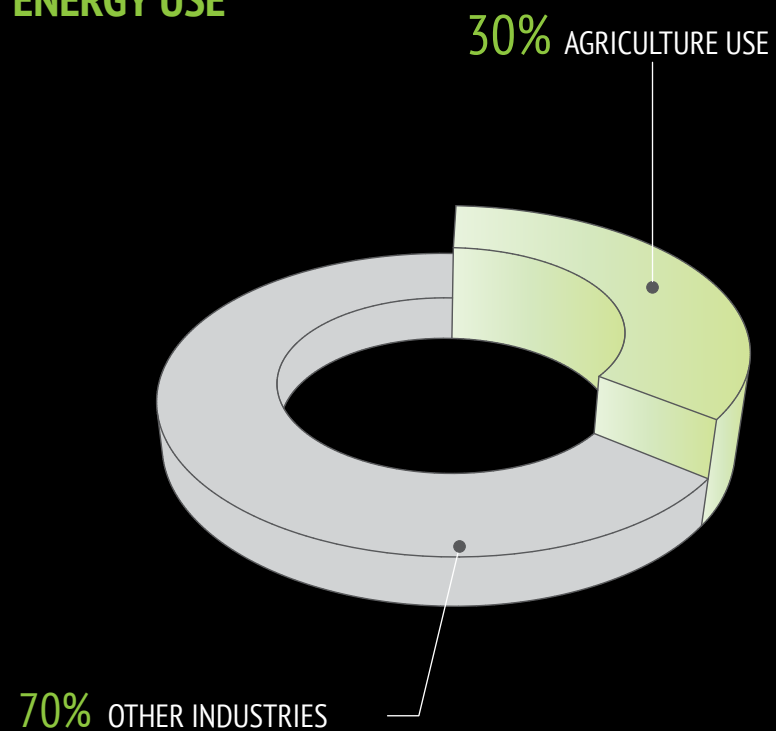




## WATER USE



## ENERGY USE

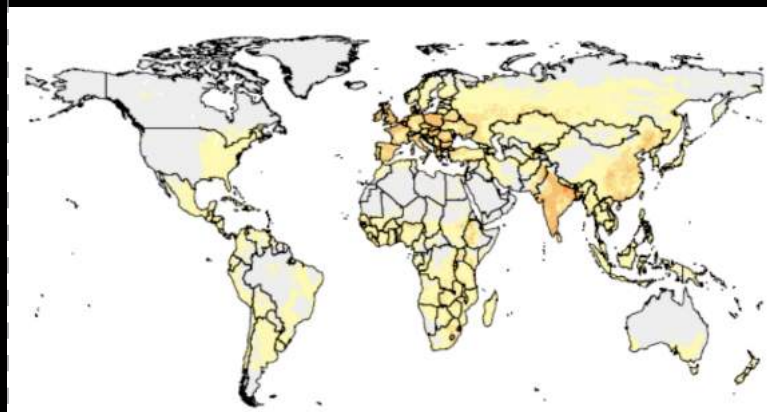


## GLOBAL AGRICULTURE LAND USE

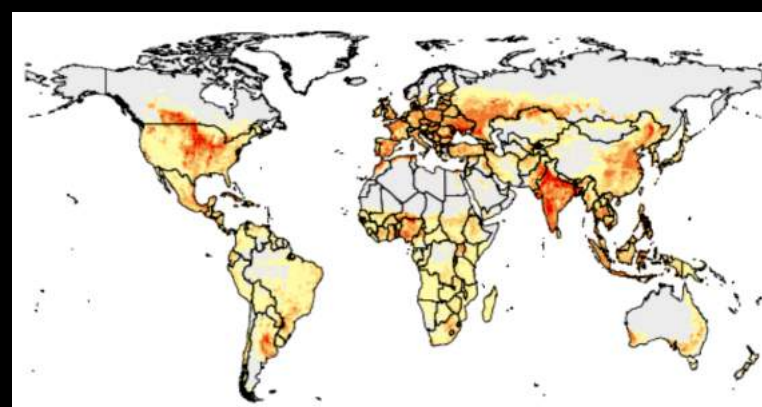
PERCENTAGE OF AREA UNDER CULTIVATION



CROPLAND EXTENT IN 1700



CROPLAND EXTENT IN 2000



Data Sources : Our World in Data

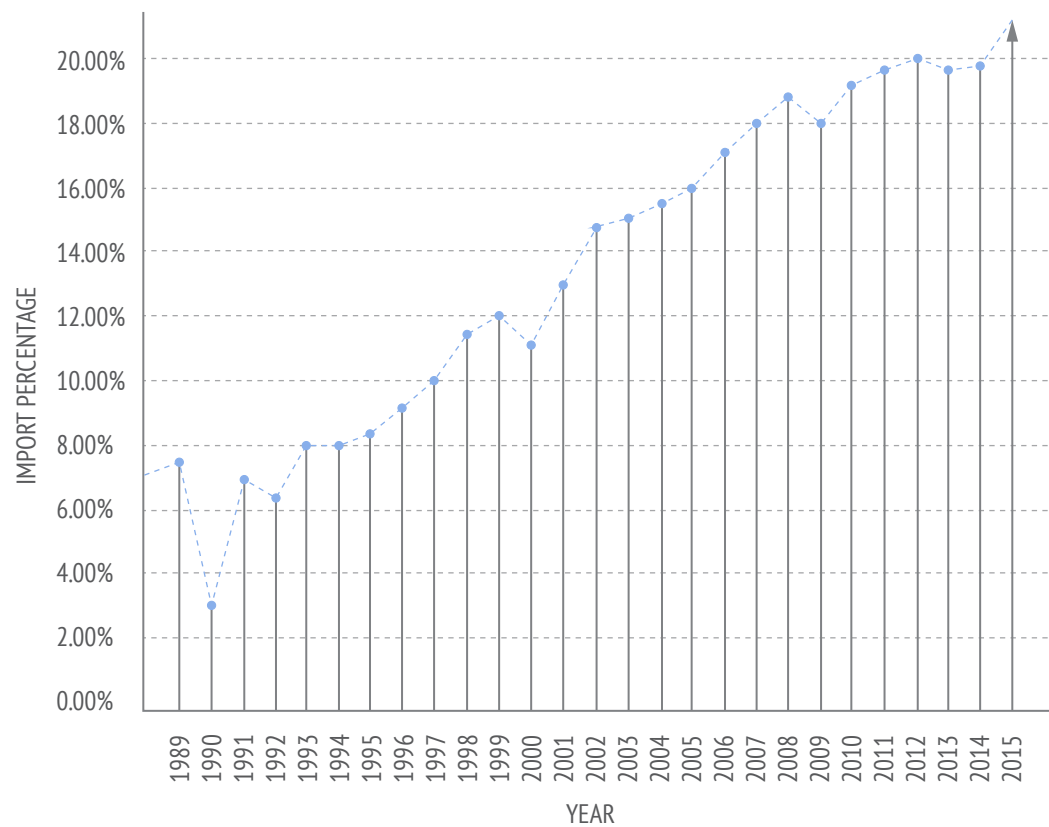


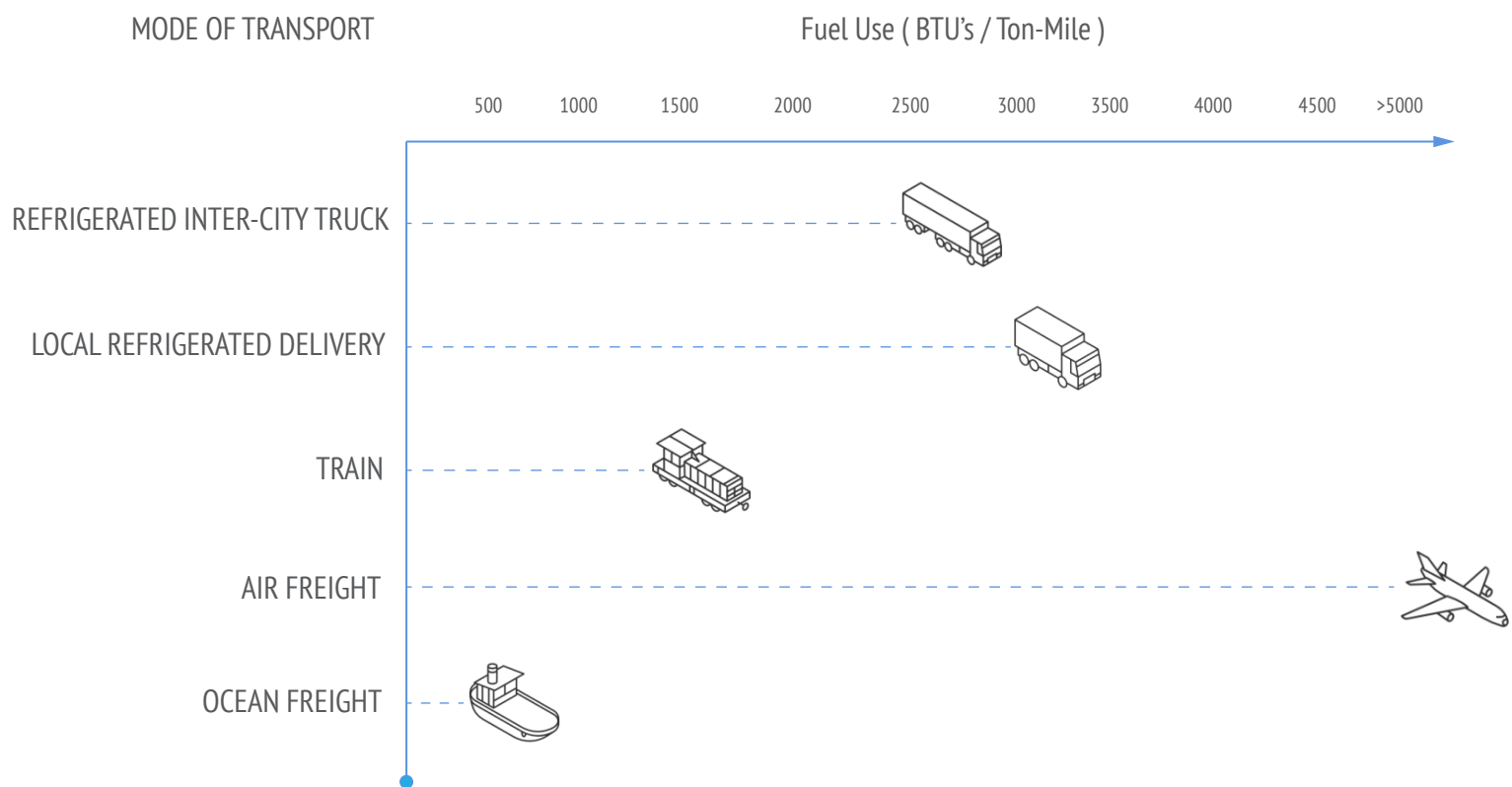
## REVERSING THE IMPORT TREND

### NYC

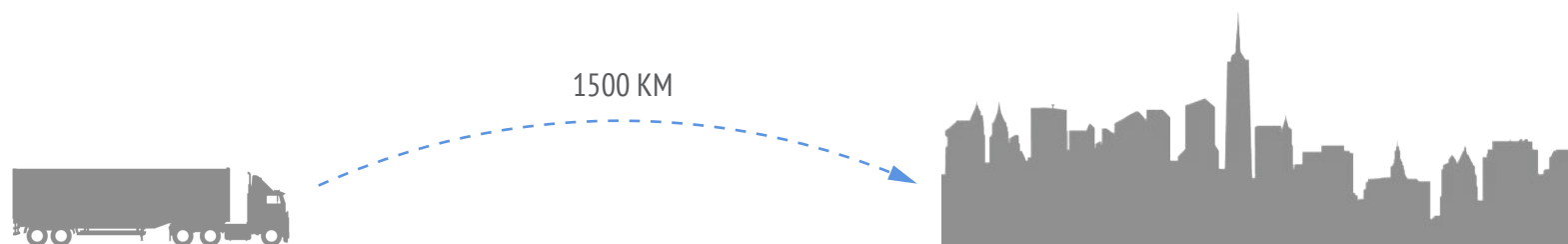
Currently New York City imports over 20% of its vegetables. By 2030 this is number is estimated to reach 40%. By implementing controlled agriculture facilities into the urban environment, we can lower imports and produce food locally.

PERCENTAGE OF VEGETABLES IMPORTED TO NEW YORK CITY

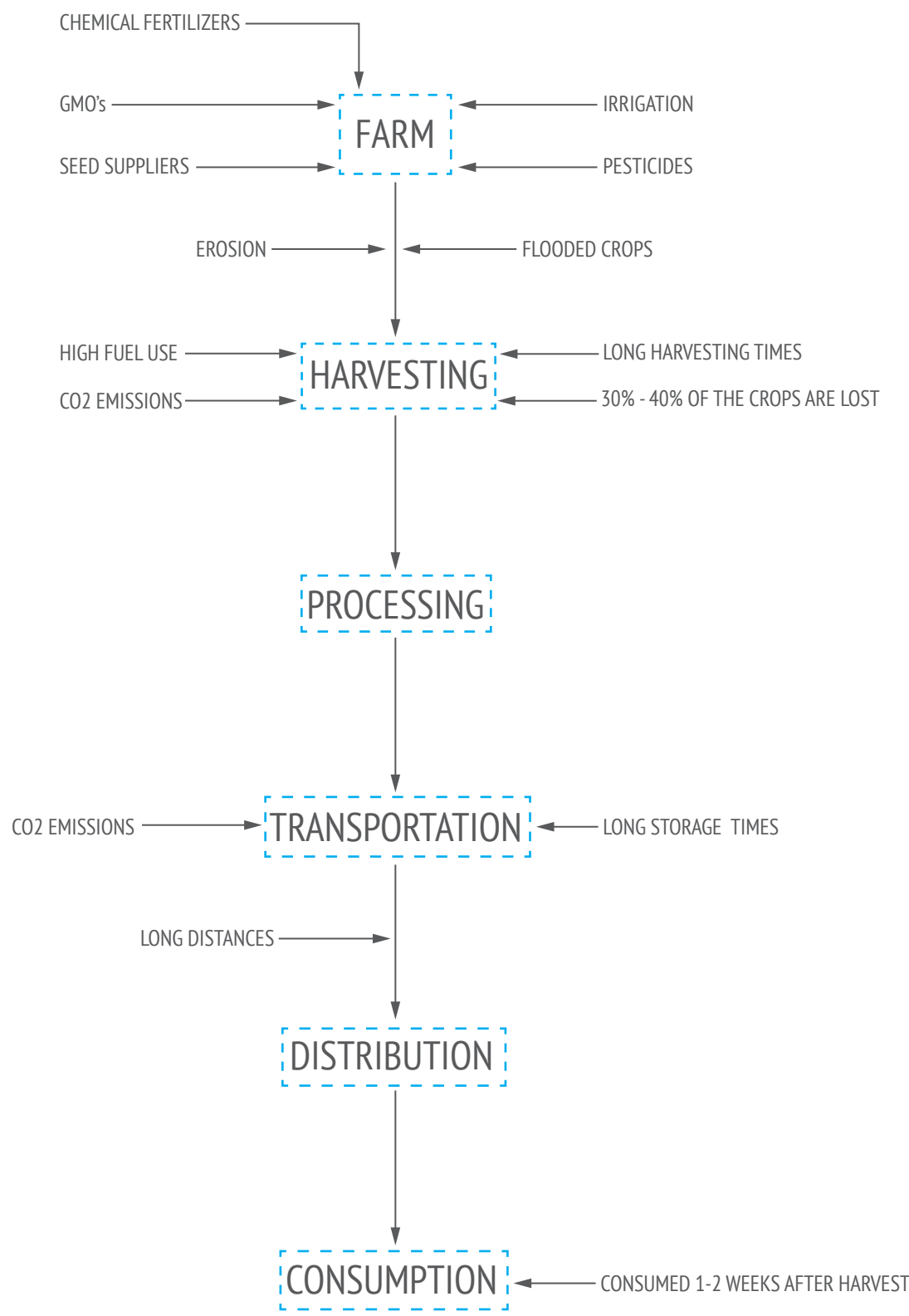




AVERAGE FOOD TRANSPORTATION DISTANCE TO NYC

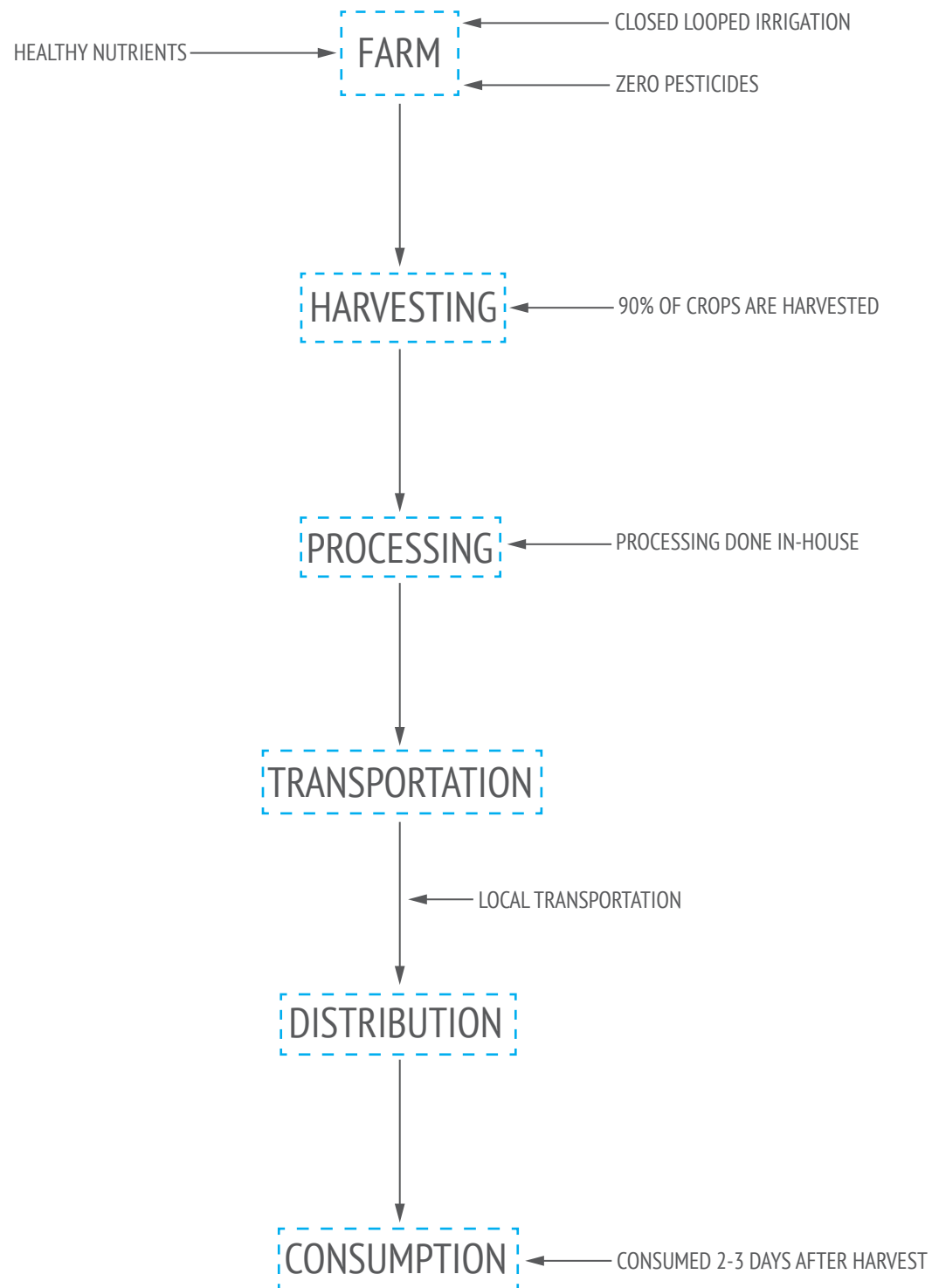


# TRADITIONAL FARMING METHODS



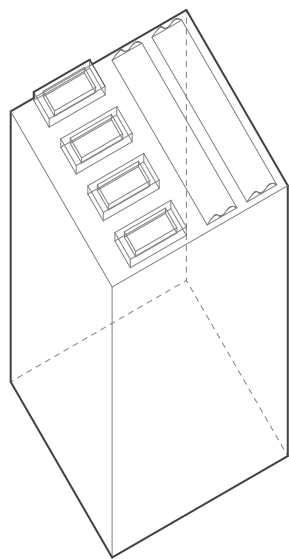
V

# VERTICAL FARMING METHODS

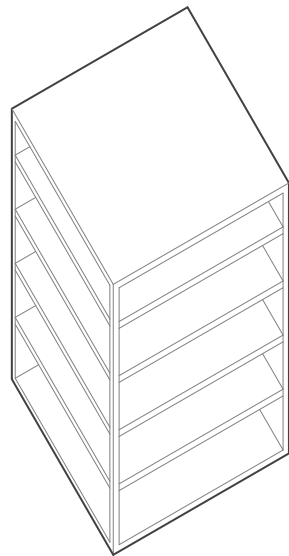




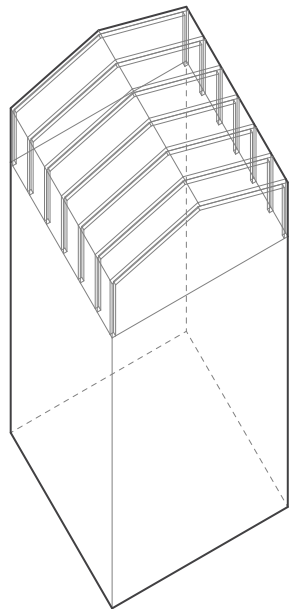
ROOFTOP SOIL-BASED FARMING



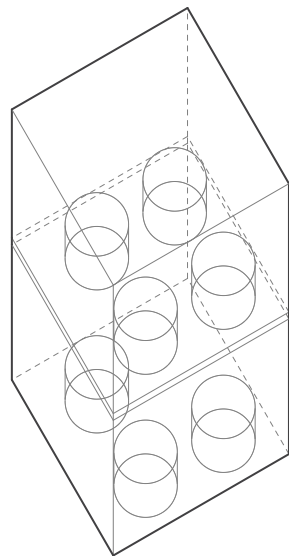
VERTICAL GREENHOUSE FACADE



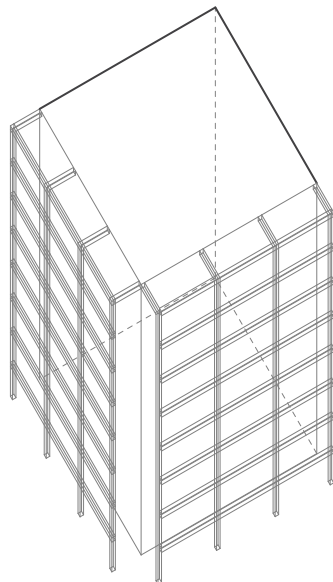
ROOFTOP GREENHOUSE



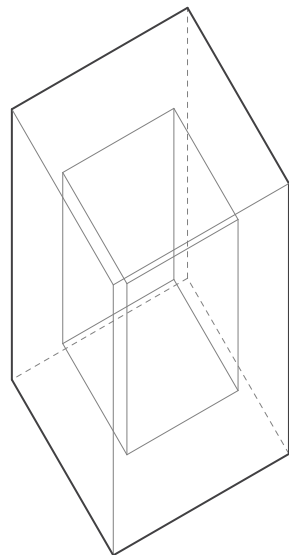
INTERIOR AQUAPONICS

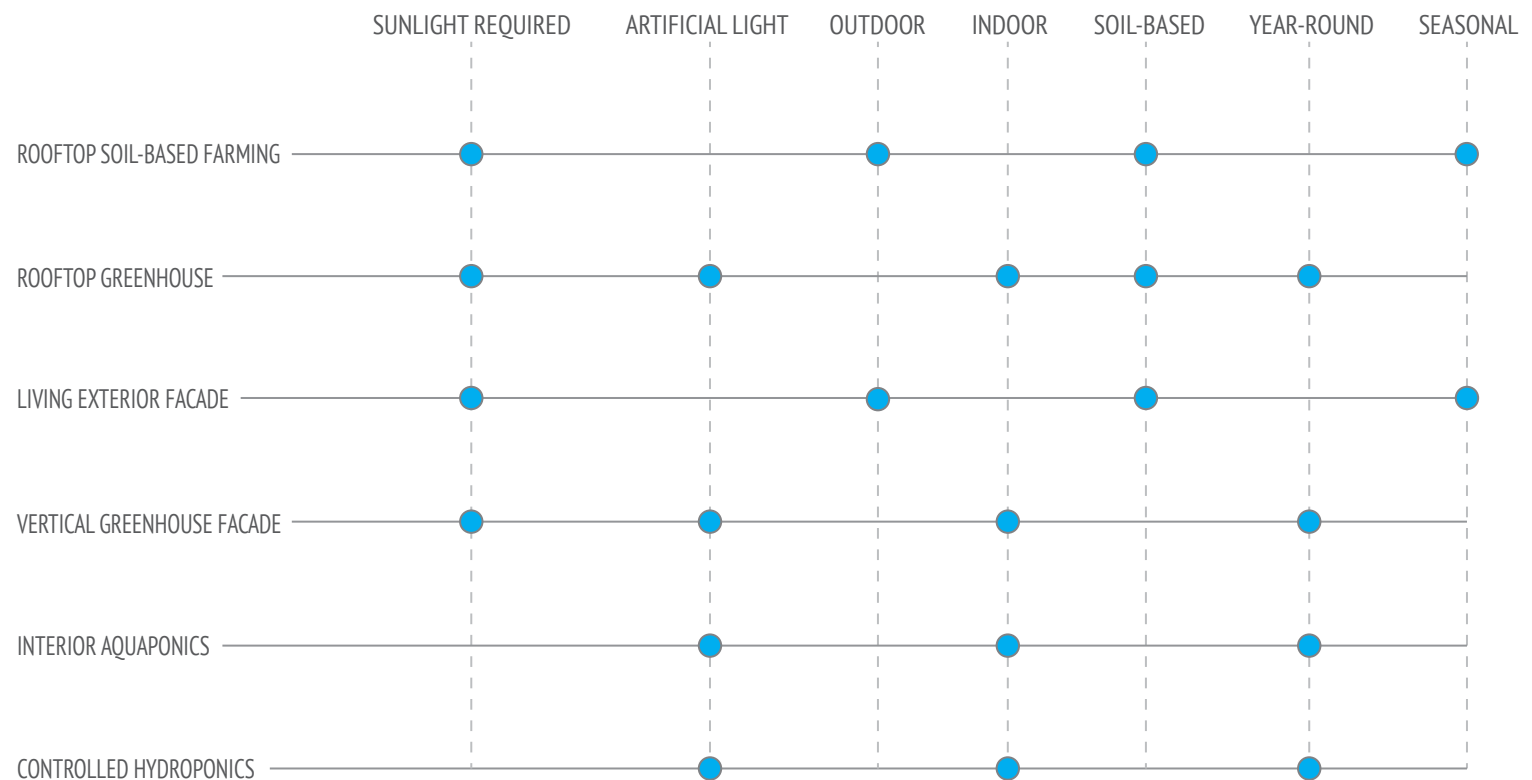


LIVING EXTERIOR FACADE



CONTROLLED HYDROPONICS





## HYRDOPONICS

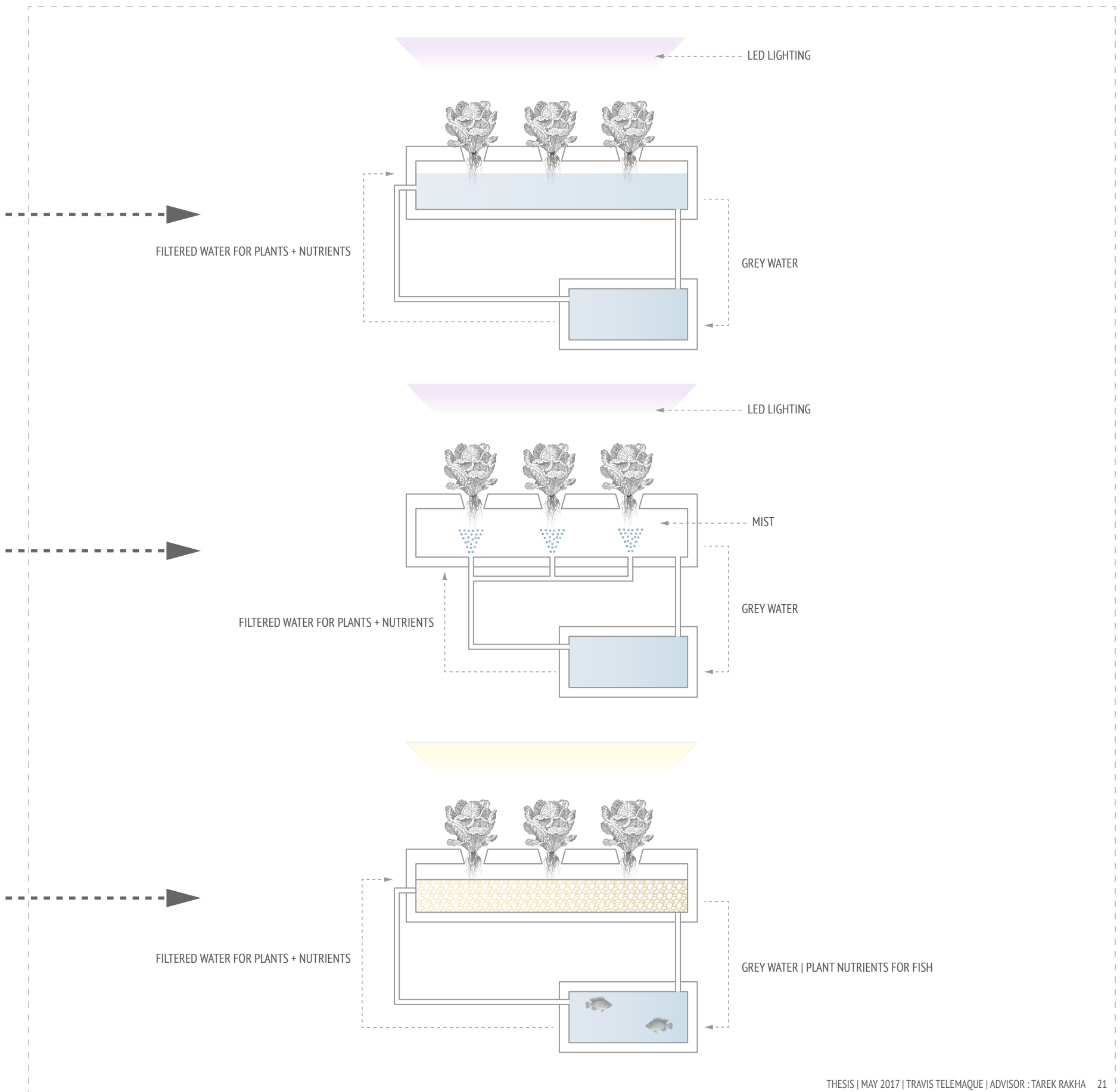
A METHOD OF GROWING PLANTS USING MINERAL NUTRIENT SOLUTIONS, IN WATER, WITHOUT SOIL.

## AEROPONICS

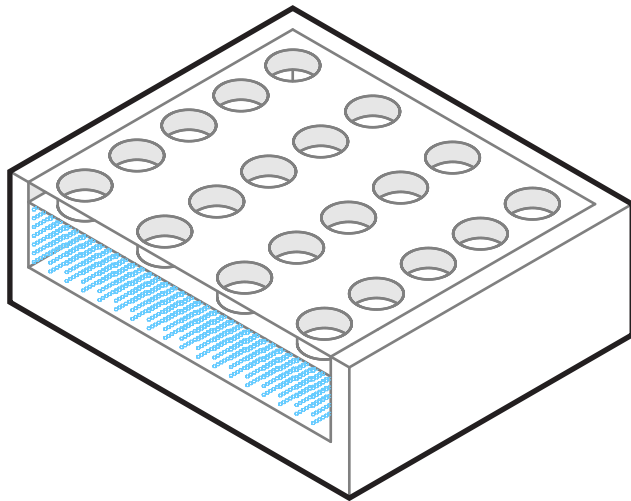
A PLANT-CULTIVATION TECHNIQUE IN WHICH THE ROOTS HANG SUSPENDED IN THE AIR WHILE NUTRIENT SOLUTION IS DELIVERED TO THEM IN THE FORM OF FINE MIST

## AQUAPONICS

A METHOD OF GROWING FISH USING AQUACULTURE AND HYDROPONIC TECHNIQUES



## AEROPONICS



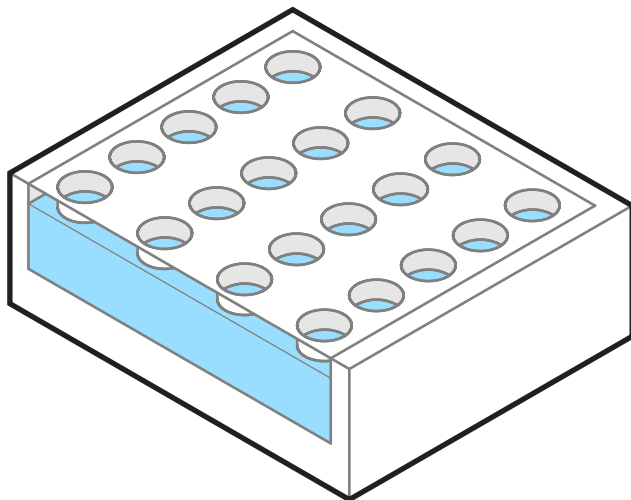
SPINACH  
MELON  
KALE  
CAULIFLOWER  
BROCCOLI



CABBAGE  
CUCUMBER  
LETTUCE  
HERBS  
EGGPLANT

SPINACH  
MINT  
STRAWBERRY  
WATERMELON  
SWISS SHARD

## HYDROPONICS



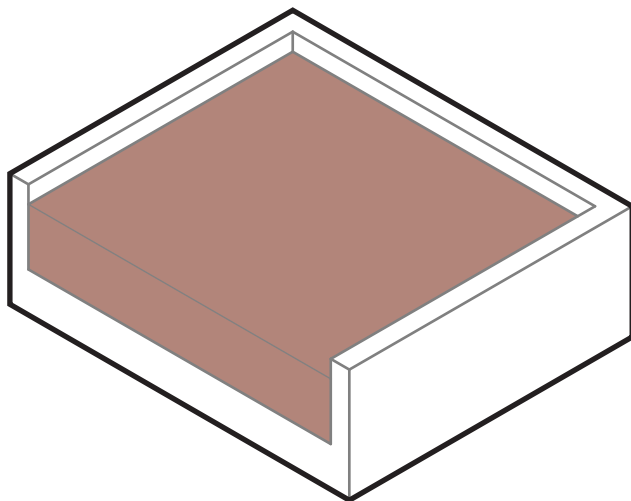
RICE  
TARO  
WILD RICE  
TOMATO  
CALTROP



LOTUS ROOT  
CABBAGE  
MIMOSA  
FLOAT HEART  
HORN FERN

MUGWORT  
SPHENOCIEA  
WATERCRESS  
FERN  
PARSLEY

## SOIL BASED



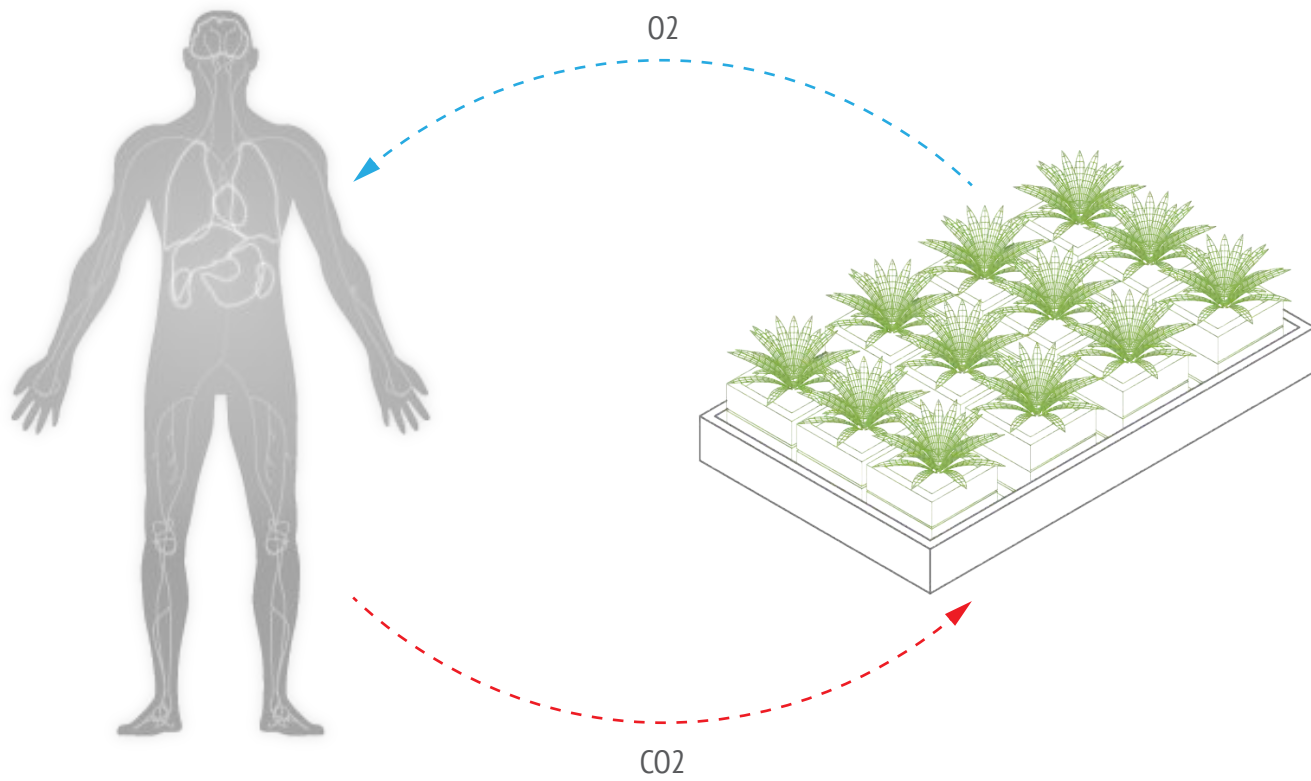
RADISH  
CARROTS  
POTATOS  
BEET  
GINGER

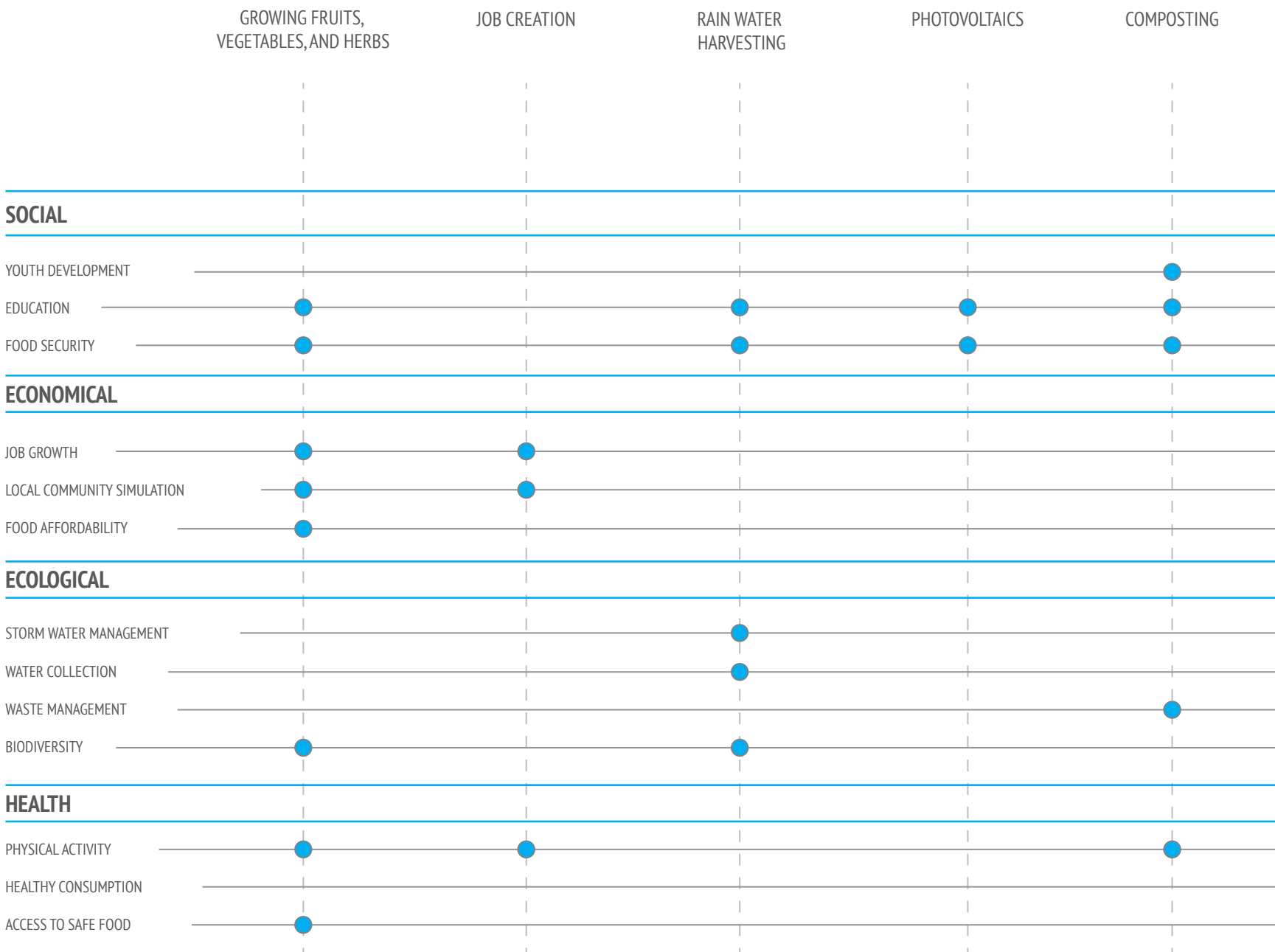


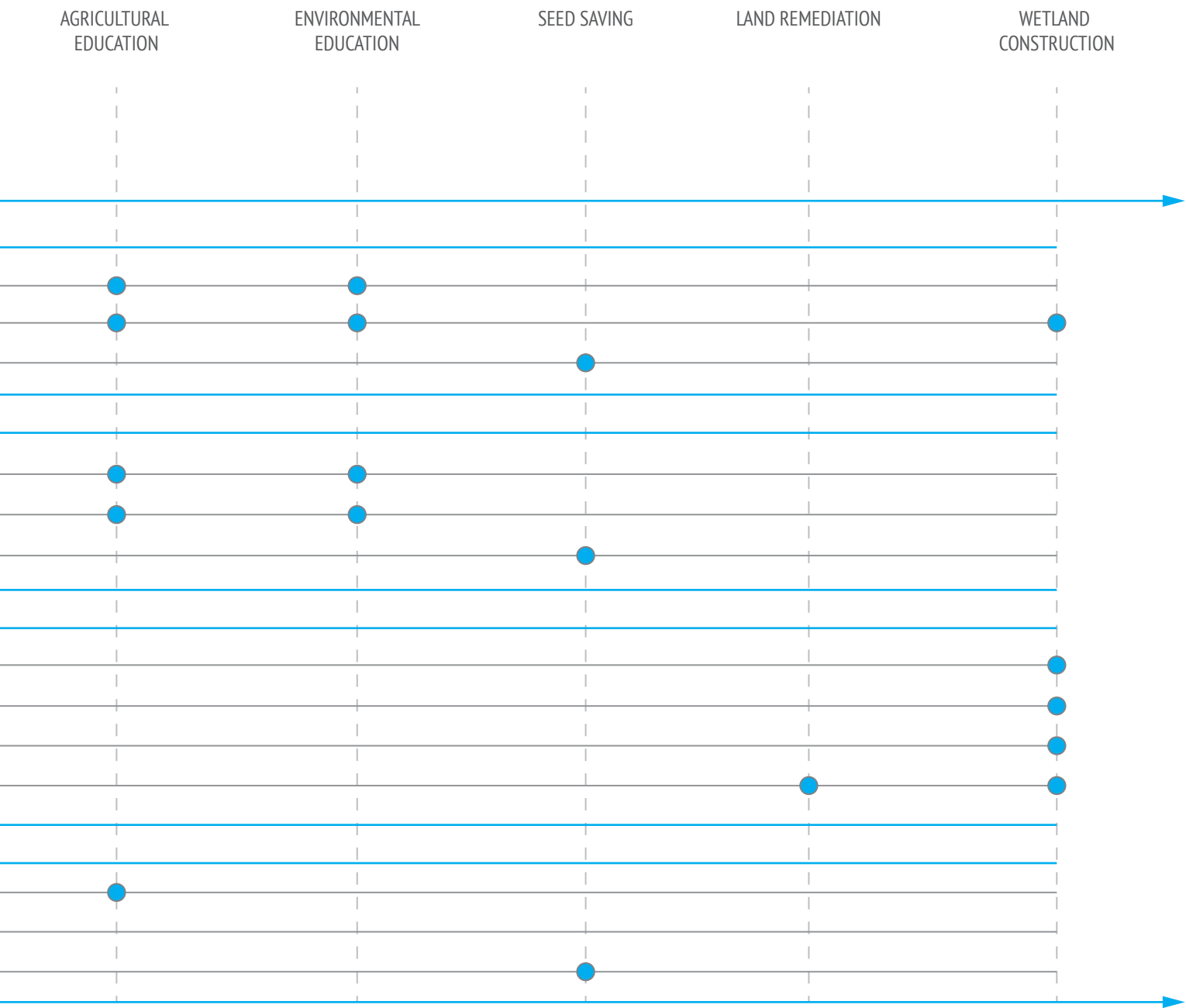
BLACK OLIVE  
GRAPEFRUIT  
MANDARIN  
ORANGE  
TOMATO

DRAGON FRUIT  
MANGO  
PEACH  
CHESTNUT  
LETTUCE

Growing plants on or within buildings helps lower carbodioxide levels and provides clean oxygen for the occupants.









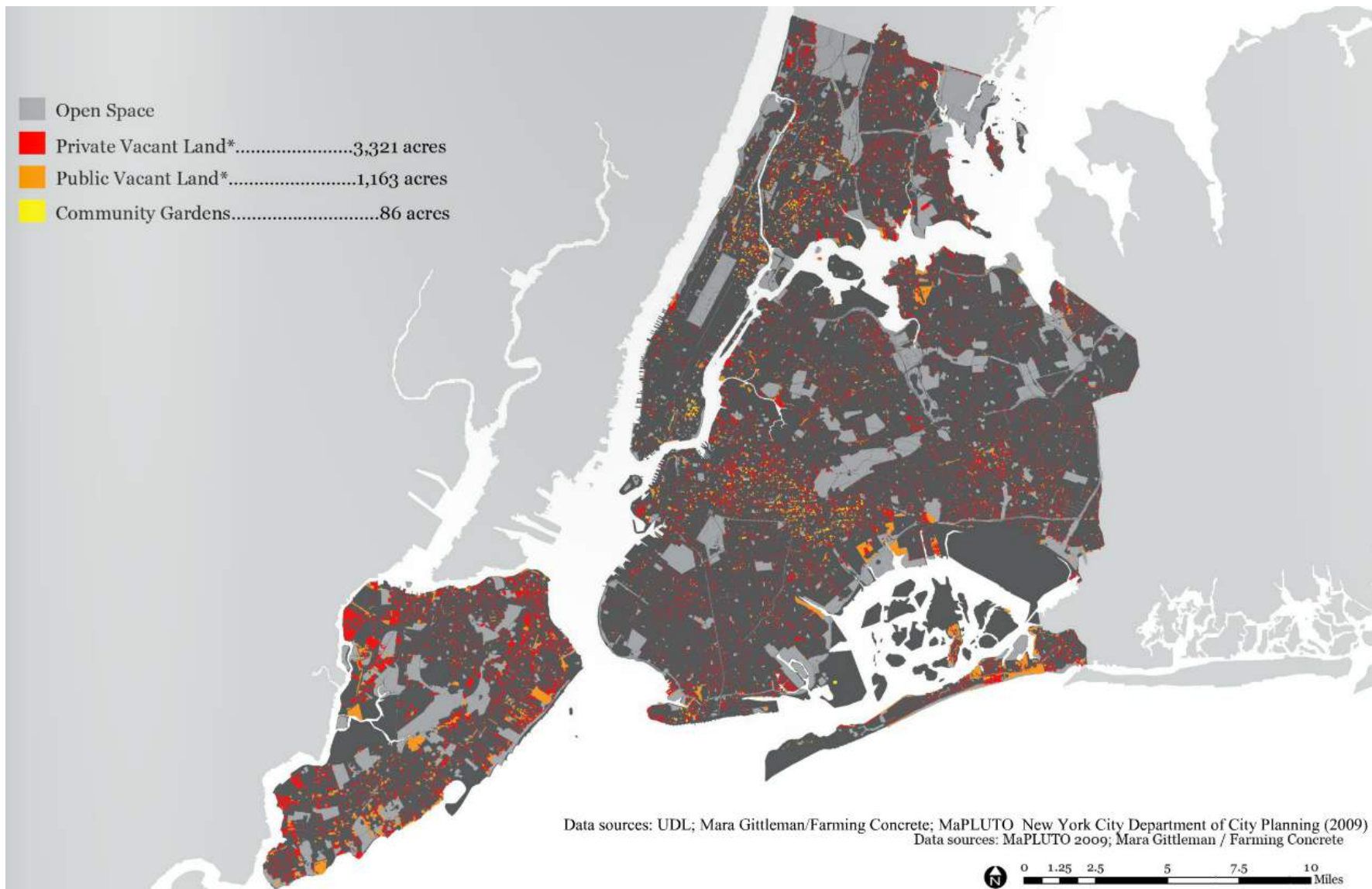
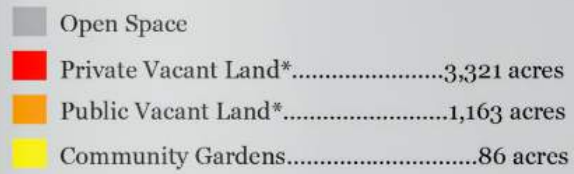
## NEW YORK CITY

urban agriculture within the city

New York City is one of the most populated cities in the United states. According to the U.S Census Bureau, 8,550,405 residents live within the five boroughs; Mahattan, The Bronx, Queens, Brooklyn, and Staten Island. The Department of City Planning states that “the city has not witnessed such a robust pace of growth since the 1920’s”(NYC.gov). As population increases our cities rely more and more on the existing food supply and the unsustainable industrial food system. This has also contributed to the rise in obesity and food related disease due to the consumption of un-healthy foods high in calories. We have no other choice but to reconsider how we produce our food in a sustainable, efficient manner.

The Urban Design Lab at Columbia University states that “Developing agriculture capacity within or close to urban areas like New York City has the potential to reduce food transportation costs and environmental impacts, provide economic and development opportunities, and reduce disparities in healthful food access that have led to the epidemic rates of obesity and diabetes among low income populations”(Columbia.edu). But where will we get the land needed to produce food within the city and at what costs will that come with? New York City is known for being the most developed city in the U.S. and because of this land availability is limited and price per square foot is substantially high. In turn, this makes it difficult to expand urban agriculture. But a potential solution could be that “public vacant land represents the greatest opportunity for urban agriculture because specific uses can be directly determined or incentivized through municipal land-use policy changes”(NYSERDA 1-4).

Urban agriculture has the potential to create value in communities where vacant land and underutilized space is present. This study with focus on New York City to determine potential sites where alternative agriculture techniques can be practiced and local food production can be established.



Producing food for 2 million people living in Manhattan excluding the surrounding boroughs is equivalent to a 35 mile radius surrounding the city.



X 150





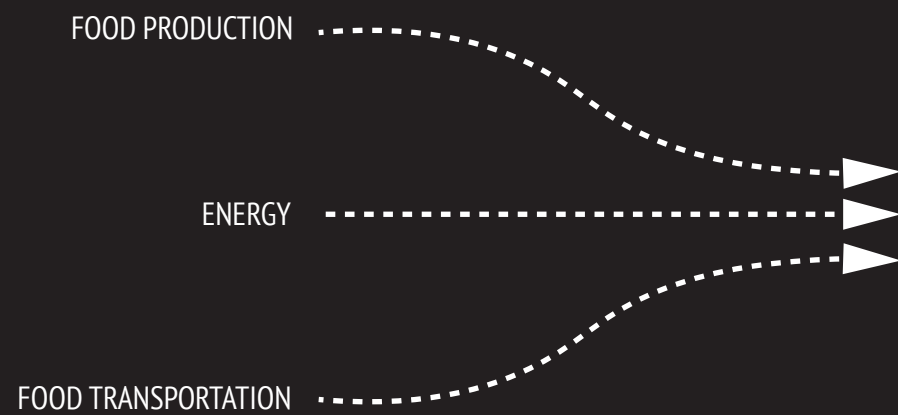
35 mile radius

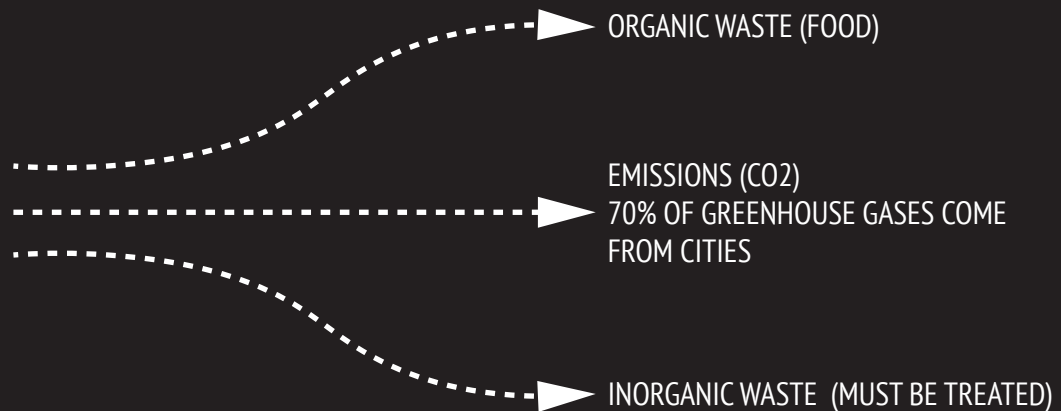
Over the course of the past 10 years New York City has worked to create community gardens, ground level farms, rooftop farms, and greenhouse indoor farms. Not only does this supply the five boroughs with local food production but it also helps reduce transportation costs and CO2 emissions. What's noticable on this map is that New York City does not have many greenhouses or indoor vertical farms. Through research and development a sustainable urban vertical farm can be intergrated into the urban fabric of the city and provide large quantities of locallly source produce.

## FOOD PRODUCTION IN NEW YORK CITY







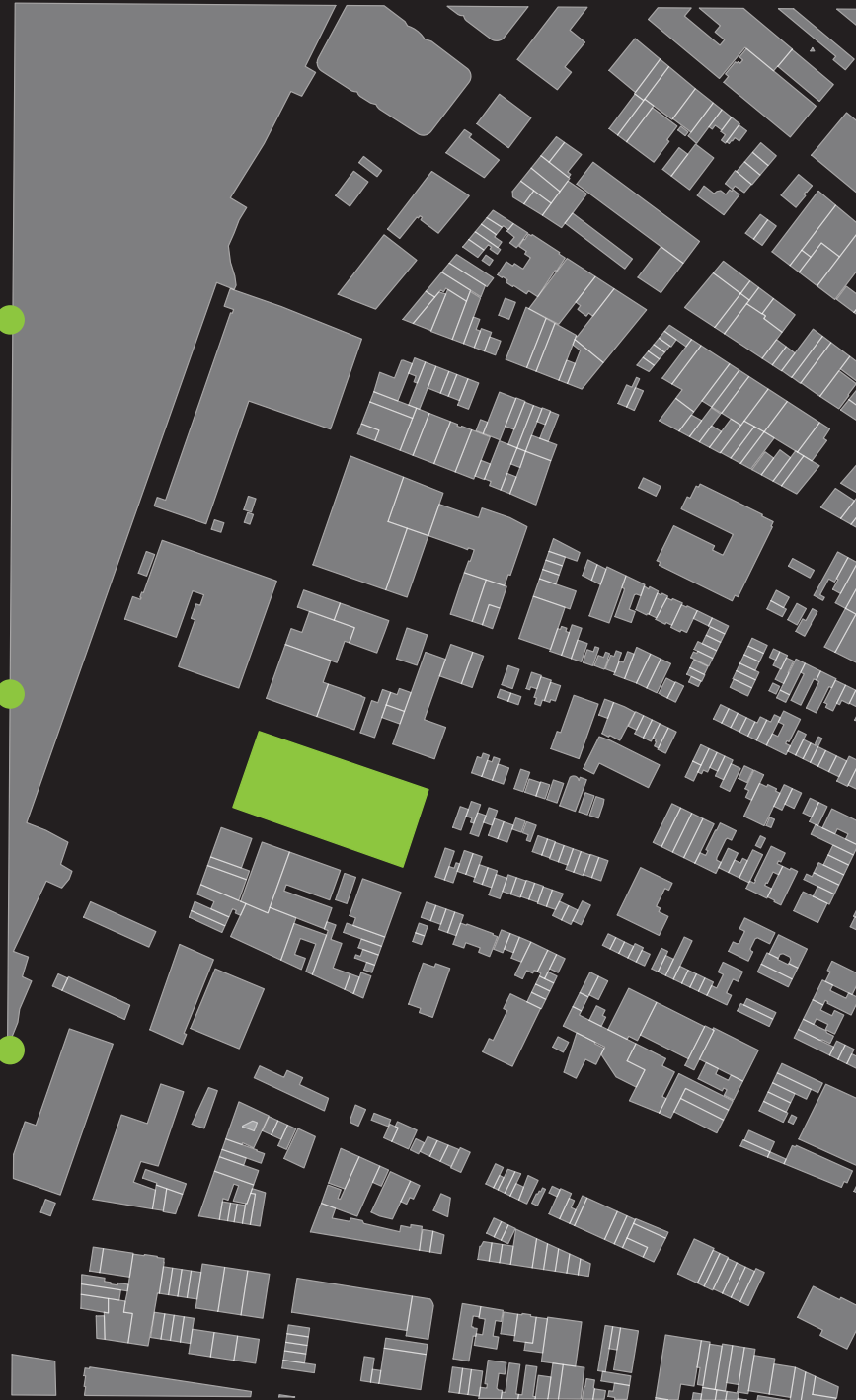




COMMUNITY ACTIVITIES

RESIDENTIAL GARDENING

RESTAURANTS



# TICAL FARM



FOOD MARKETS

RESEARCH FACILITIES

PROCESSING & RECYCLING

## LONG ISLAND CITY ROOFTOP FARM

BROOKLYN GRANGE FARM DESIGN

## BROOKLYN NAVY ROOFTOP FARM

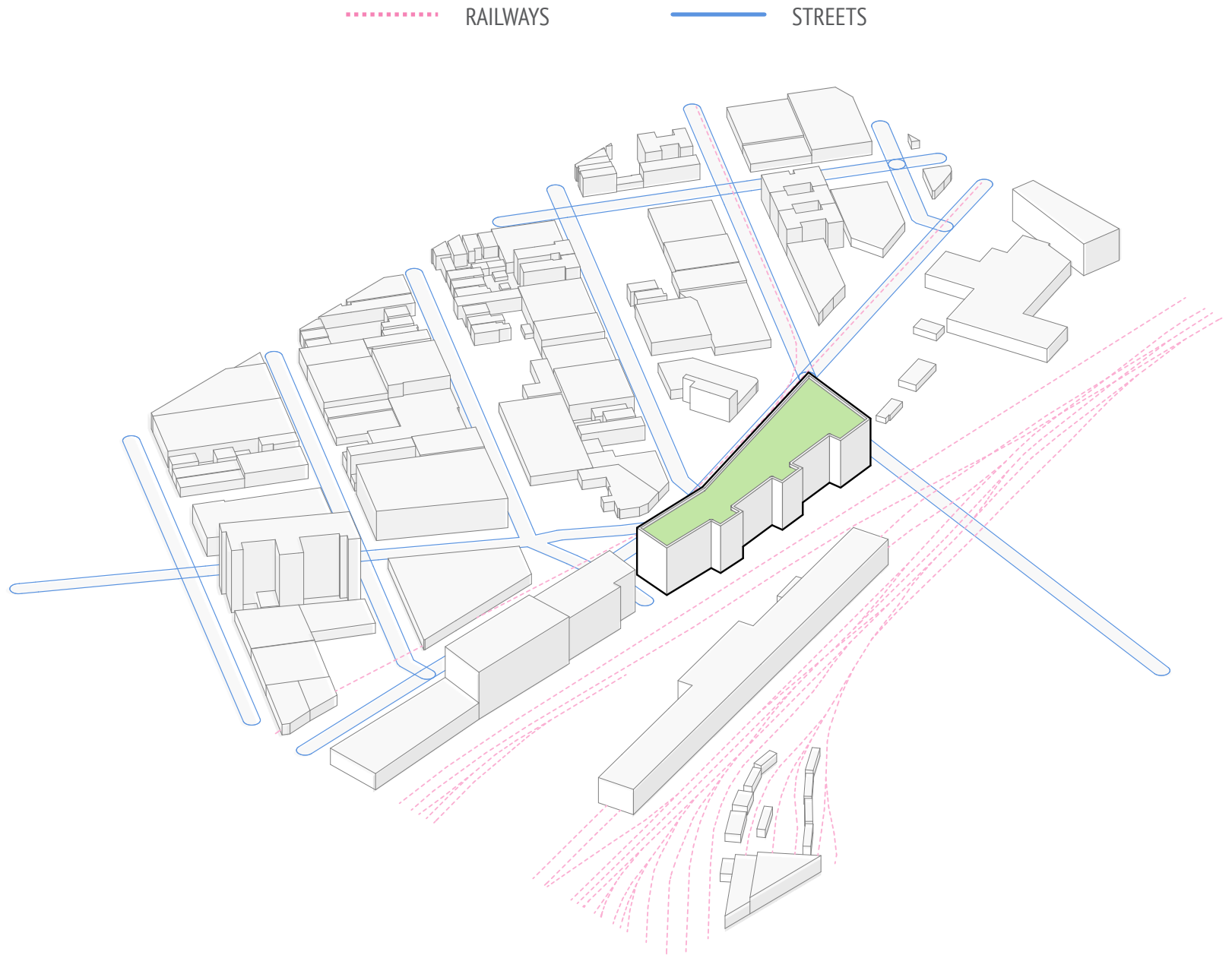
BROOKLYN GRANGE FARM DESIGN



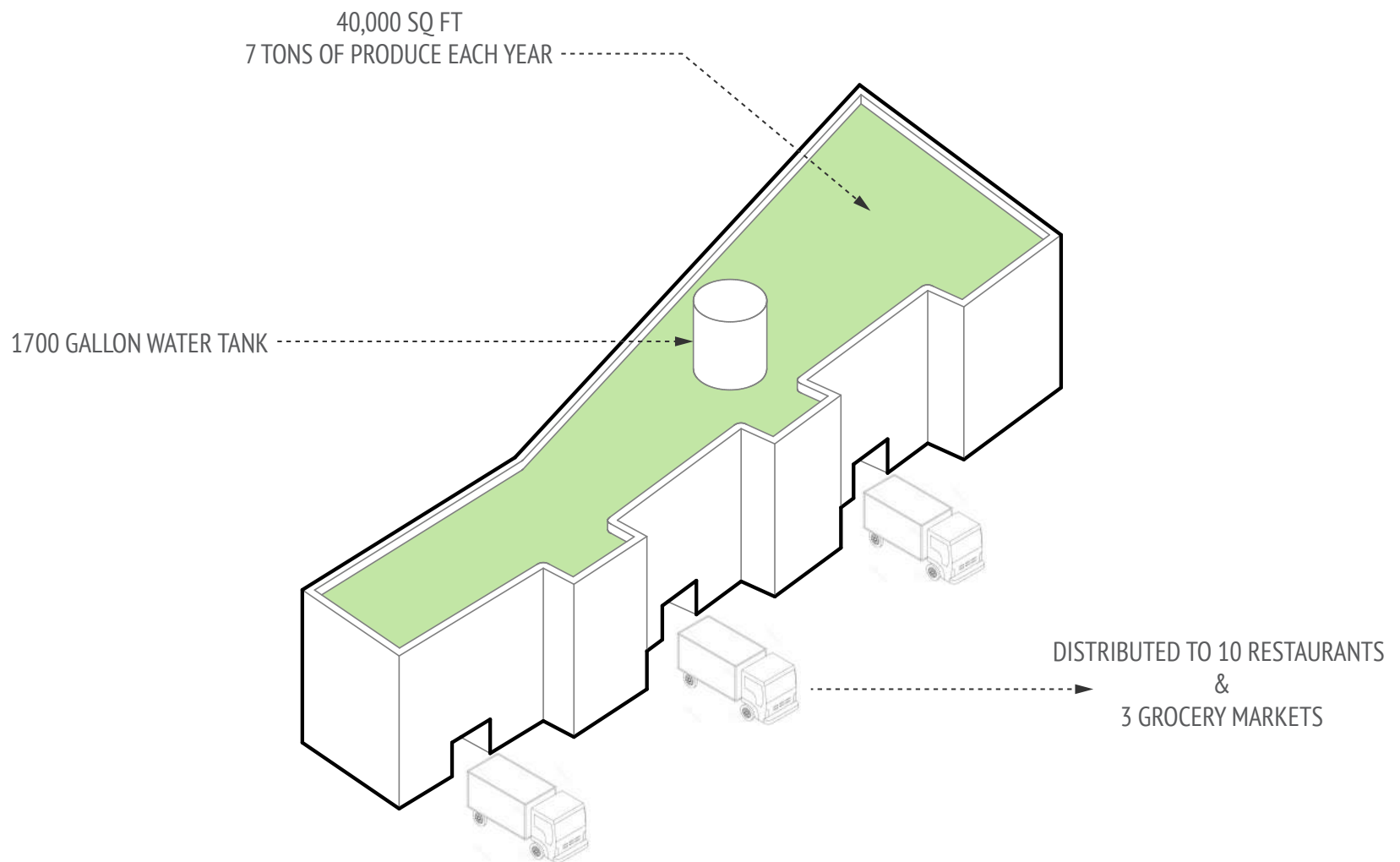




Long Island City Farm is strategically located close to truck delivery routes and railways to maximize its distribution ability. Additionally, the heights of the surrounding buildings are lower than the farm allowing the plants to have maximum solar access.

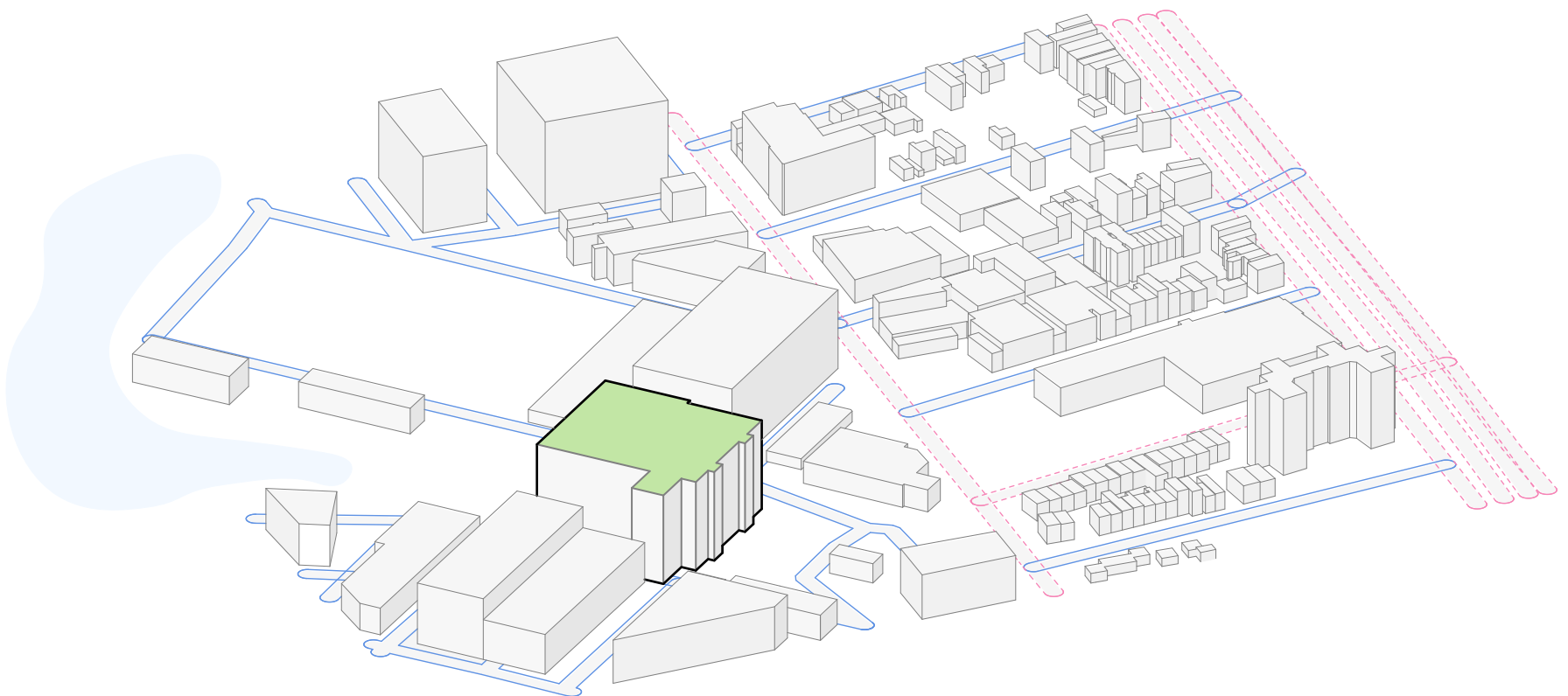


With over 30 different species, tomatoes are the main crop that is grown on the rooftop farm. Herbs, lettuce, carrots, beets, beans, and radishes are also grown over the 9 month growing season. Special soil is used which is 20% lighter than traditional soil. This soil helps reduce the load on the buildings structure.

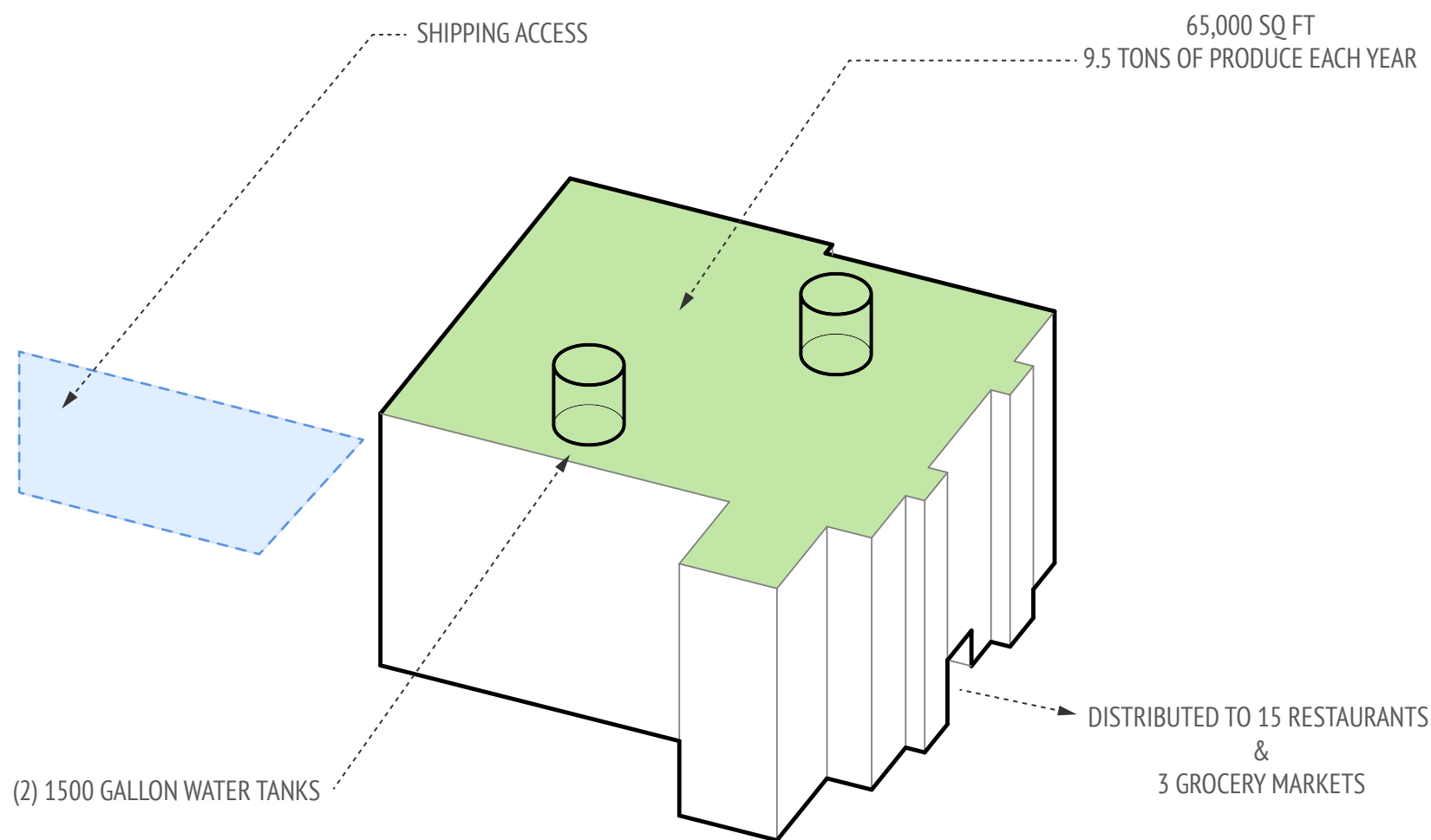


Brooklyn Navy Yard Rooftop Farm is strategically located next to a shipping yard along the East River. Additionally, there is great truck delivery routes along the Brooklyn-Queens expressway. The neighboring buildings are equal in height or smaller than the farm which allows the plants to have maximum sunlight throughout the day.

..... PRIMARY HIGHWAY      ————— SECONDARY STREETS



With over 30 different species, tomatoes are the main crop that is grown on the rooftop farm. Herbs, lettuce, carrots, beets, beans, and radishes are also grown over the 9 month growing season. Special soil is used which is 20% lighter than traditional soil. This soil helps reduce the load on the buildings structure.



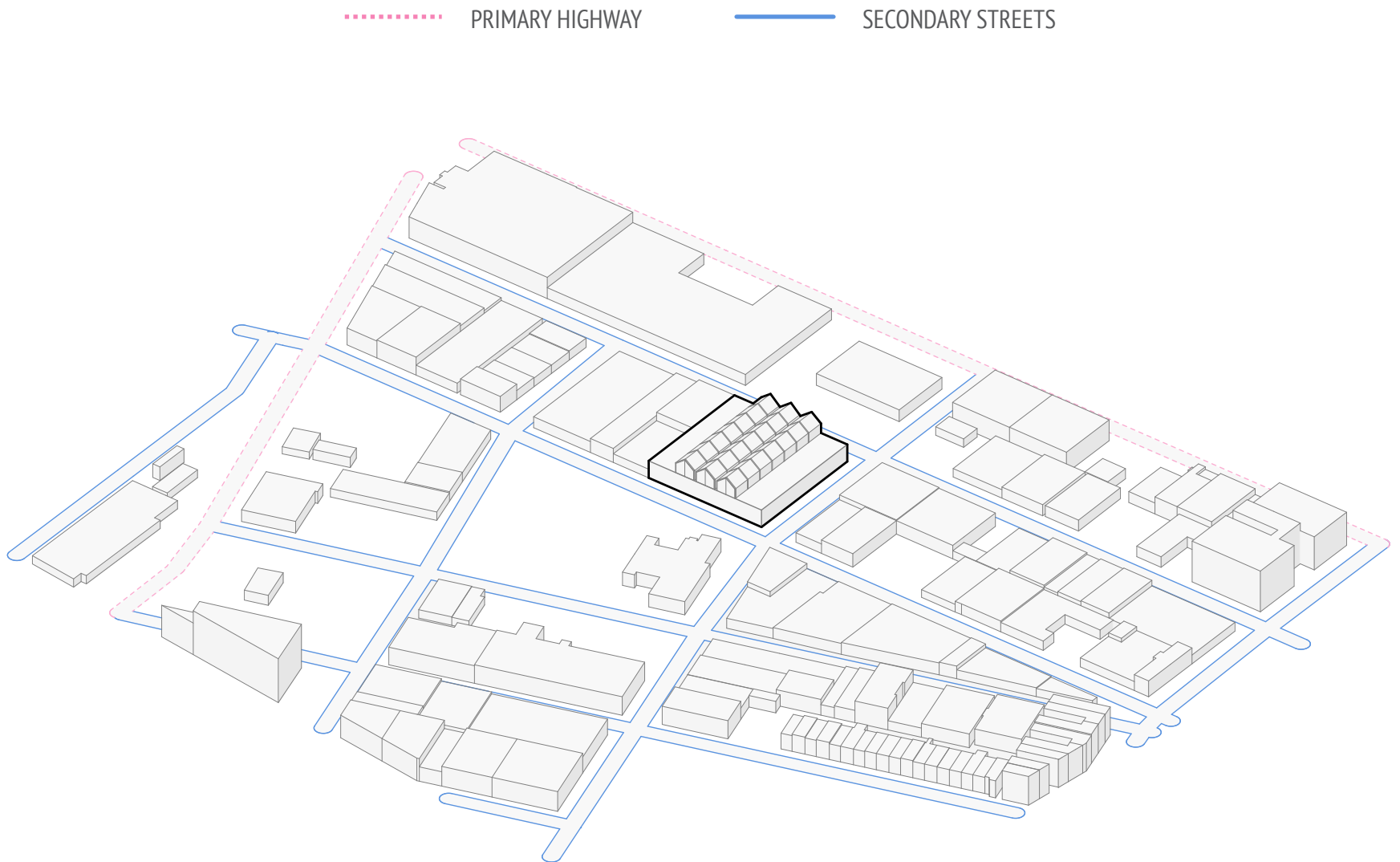


GREENPOINT GREENHOUSE  
GOTHAM GREENS DESIGN

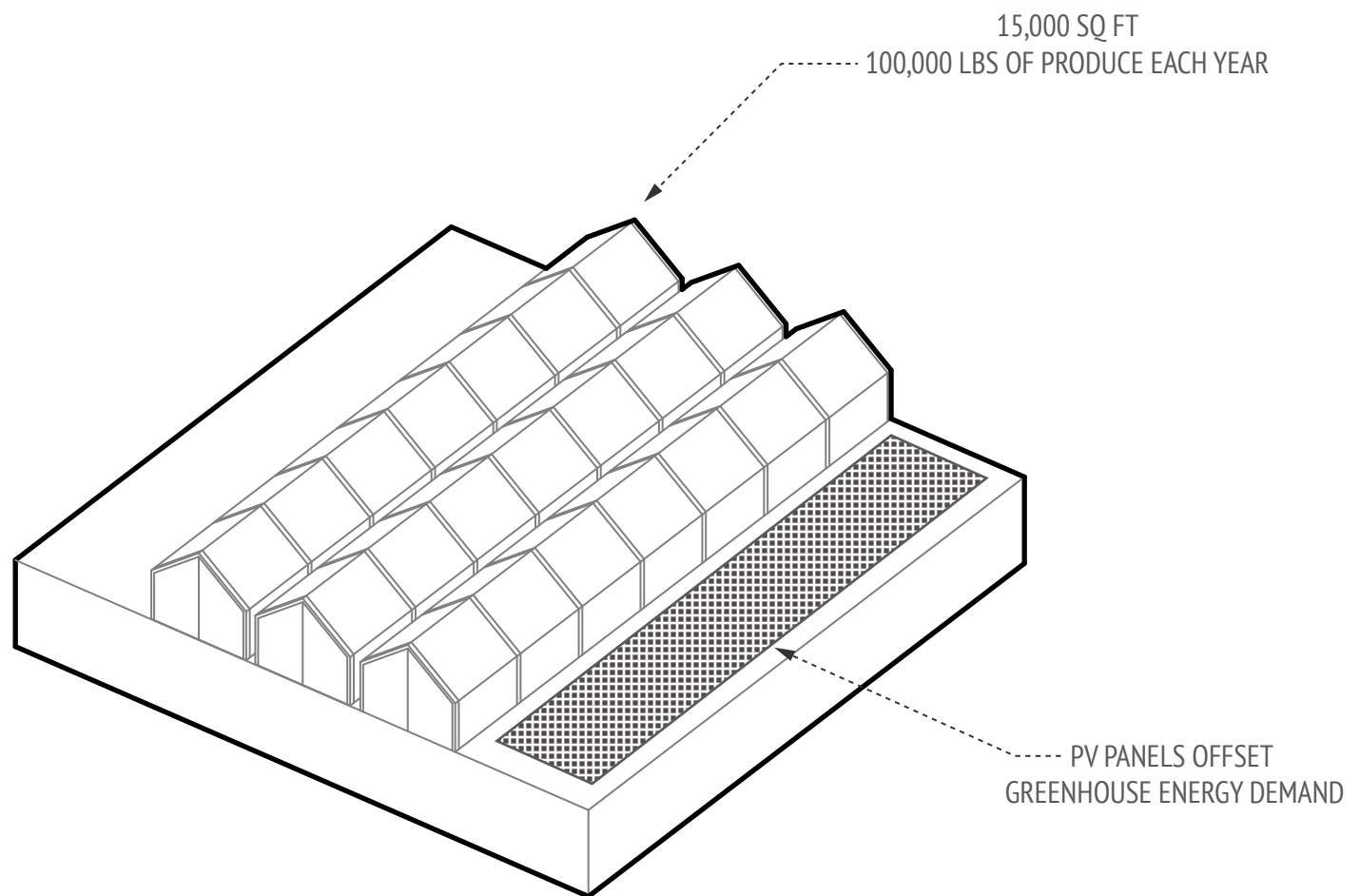
WHOLE FOODS GREENHOUSE, GOWANUS  
GOTHAM GREENS DESIGN



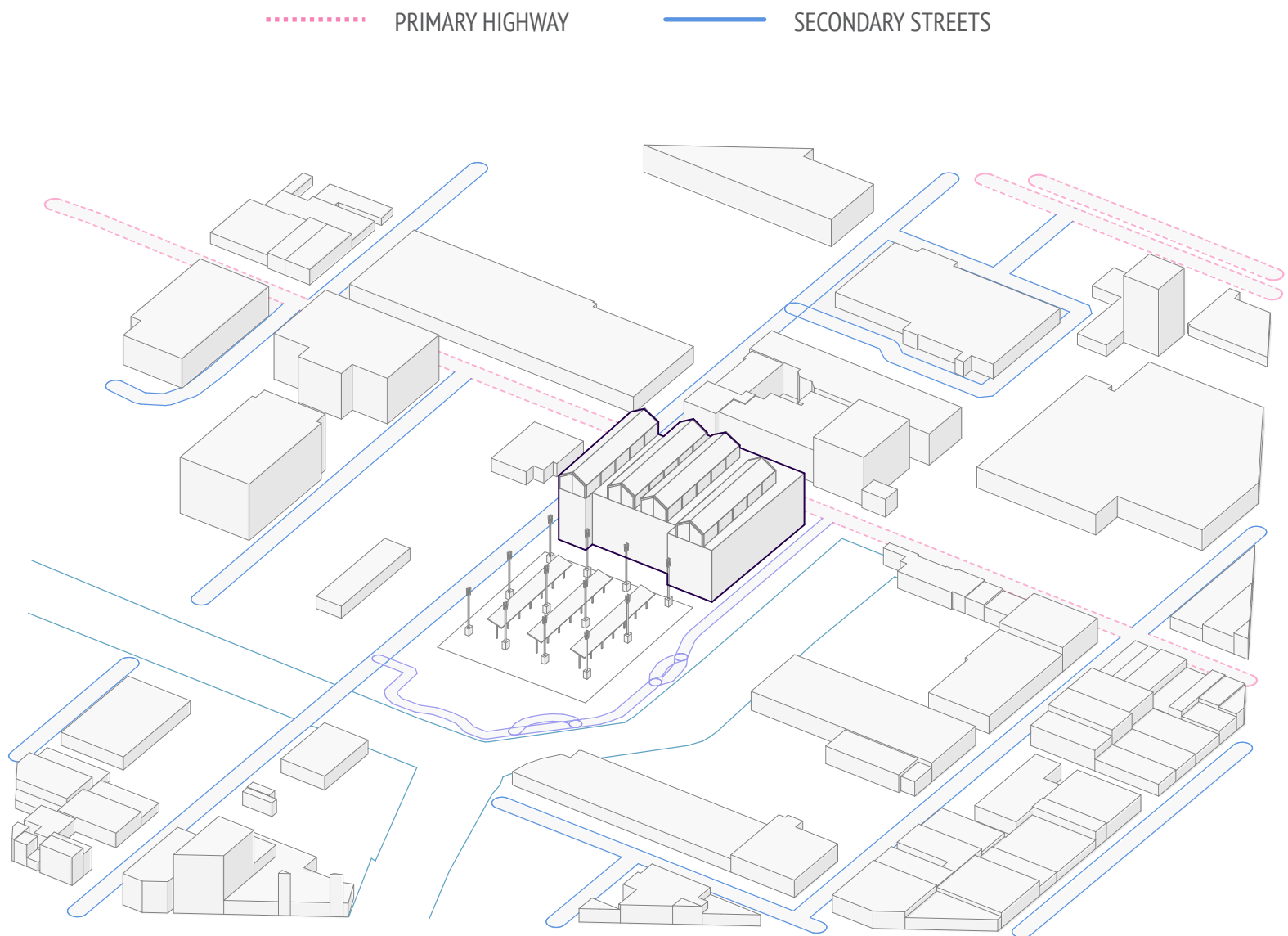
Greenpoint Gotham Greens in Brooklyn is conveniently located near the Brooklyn-Queens expressway so that their produce can be distributed efficiently to retailers. Additionally, the surrounding buildings are lower than the greenhouse, in turn the plants receive maximum sunlight.



The greenhouse can produce 5 1/2 times more food than the Brooklyn Navy Yard Rooftop Farm which is 4 times larger than the Greenpoint Gotham Greens. Since the greenhouse has a small footprint the company was able to install solar panels that supply the greenhouse with a sufficient amount of energy.

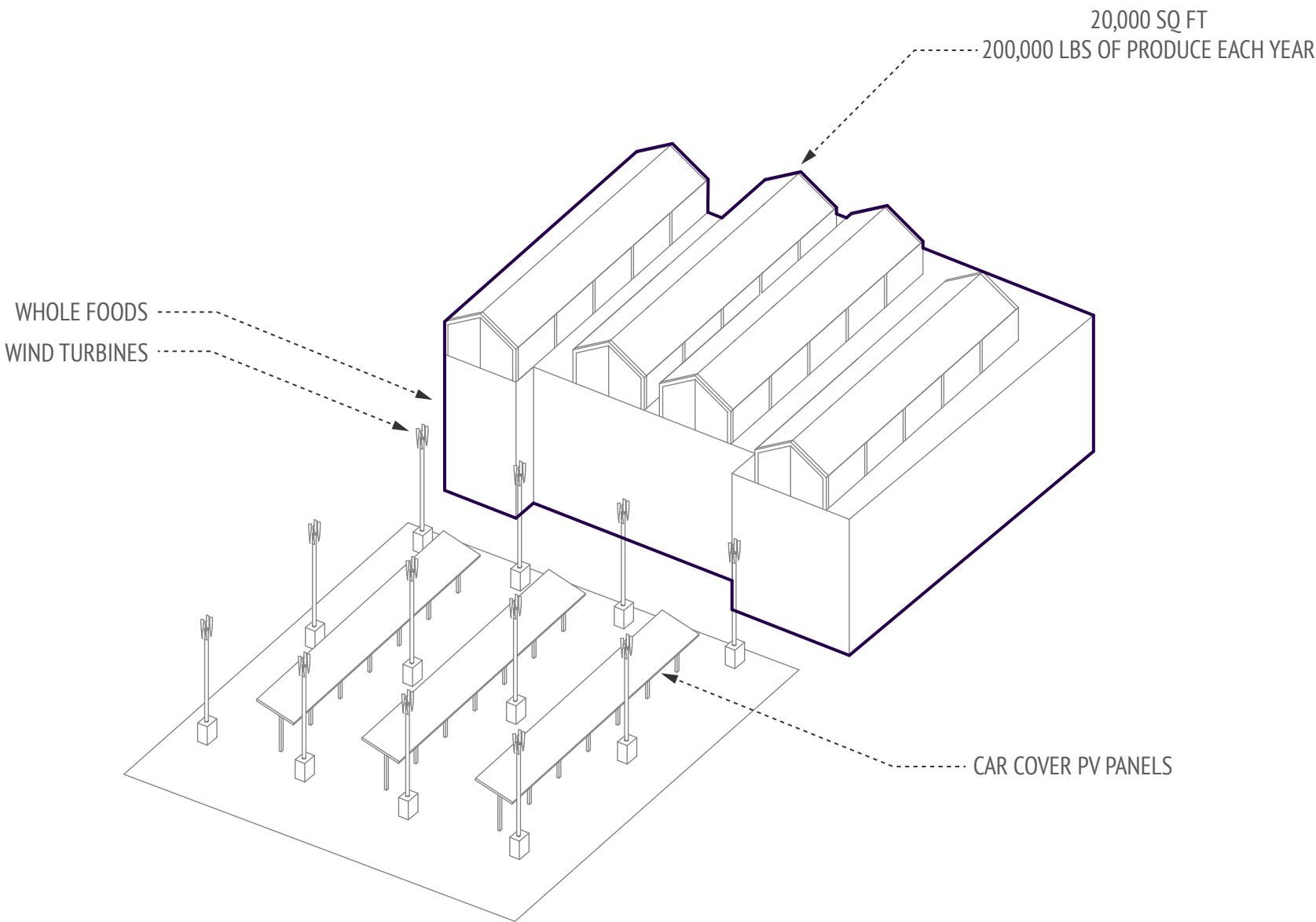


Whole Foods Gotham Greens in Brooklyn was constructed on an open lot which give the plants maximum solar exposure. It is the first large scale greenhouse integrated into a supermarket. Additionally, the greenhouse is located within Brooklyn and close to the city which allows farmers to harvest and sell in the same day.





The greenhouse can produce 10 times more food than the Brooklyn Navy Yard Rooftop Farm which is 3 times larger than the Whole Foods Gotham Greens. Additionally, the company has included solar panels as car cover ports in the parking lot and light post with wind turbines on the top. The energy generated from these systems is transfer back to the greenhouse.



## PASONA 02 URBAN FARM

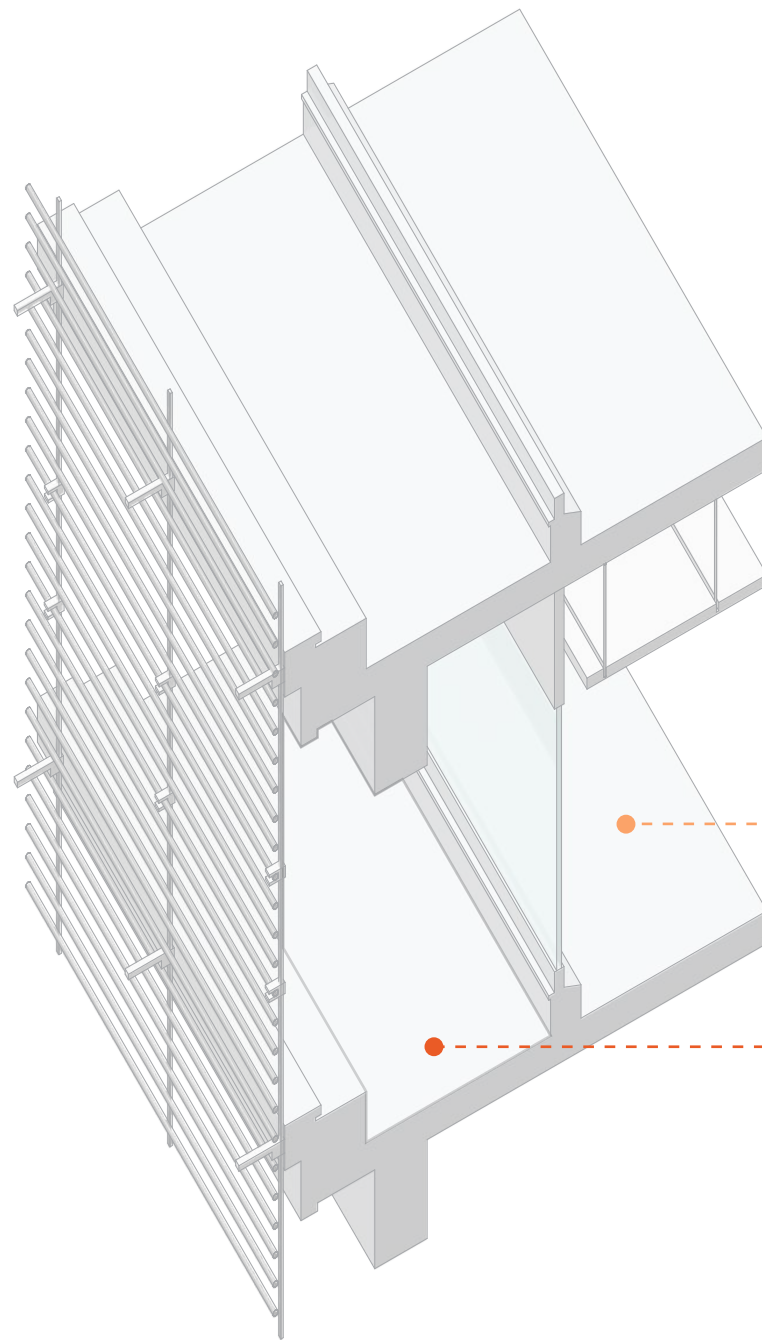
KONO DESIGN

Located in downtown Toyko, Pasona 02 is a 215,000 square feet renovated office building that has over 200 different species of plants which are harvested and prepared within the building. The renovation consist of a double skinned green facade, office spaces, cafeteria, rooftop garden, and urban farming facilities. The space dedicated to the farm is over 43,000 square feet which is enough to feed all the workers daily throughout the year. “It is the largest and most direct farm-to-table of it’s kind ever realized inside an office building in Japan.

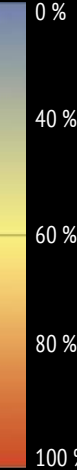
Pasona 02 uses both soil-based and hydroponic farming techniques equipped with smart LED lighting and climate controls. Pasona headquarters supports and educates over 350 student farmers so that generations to come have a better understanding of food production within dense urban cities. “Pasona urban farm is beyond aesthetic and visual improvement. It creates a unique workplace environment that promotes worker’s productivity, mental health, and social interaction and engages the wider community of Toyko by showcasing the benefits and technology of urban agriculture”. The food produced within the building not only supports the workers but supplies the city as well.







DAYLIT OCCUPIED HOURS  
PER YEAR

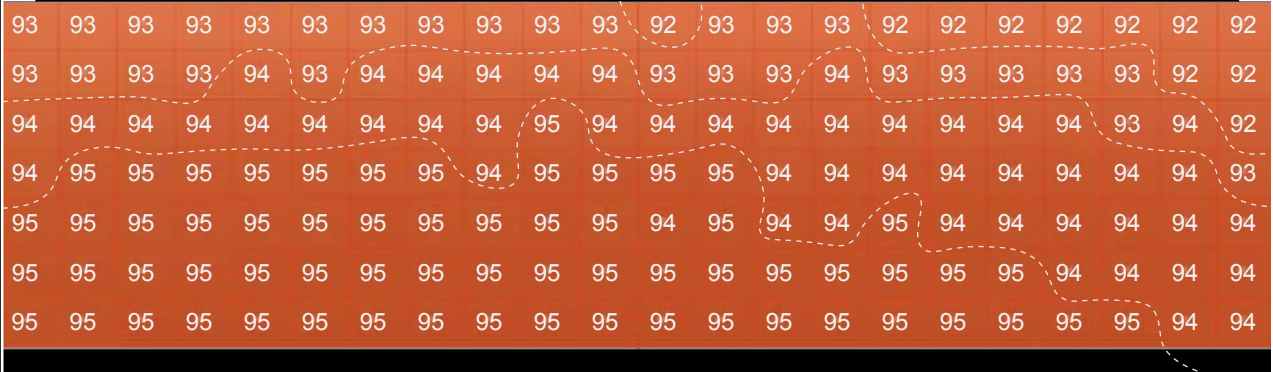


DAYLIGHT AUTONOMY DISTRIBUTION  
PASONA O2 FACADE STUDY

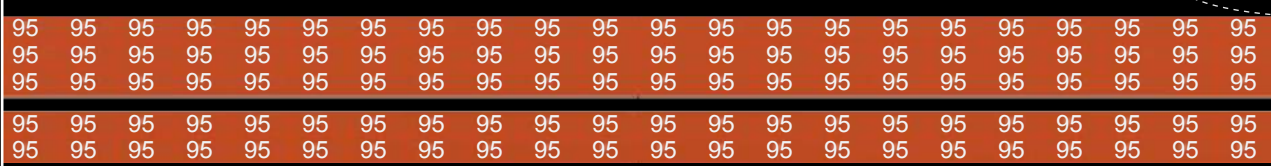
nodegroup01: Mean Daylight Autonomy = 46.6 % of  
time occupied



WINDOW



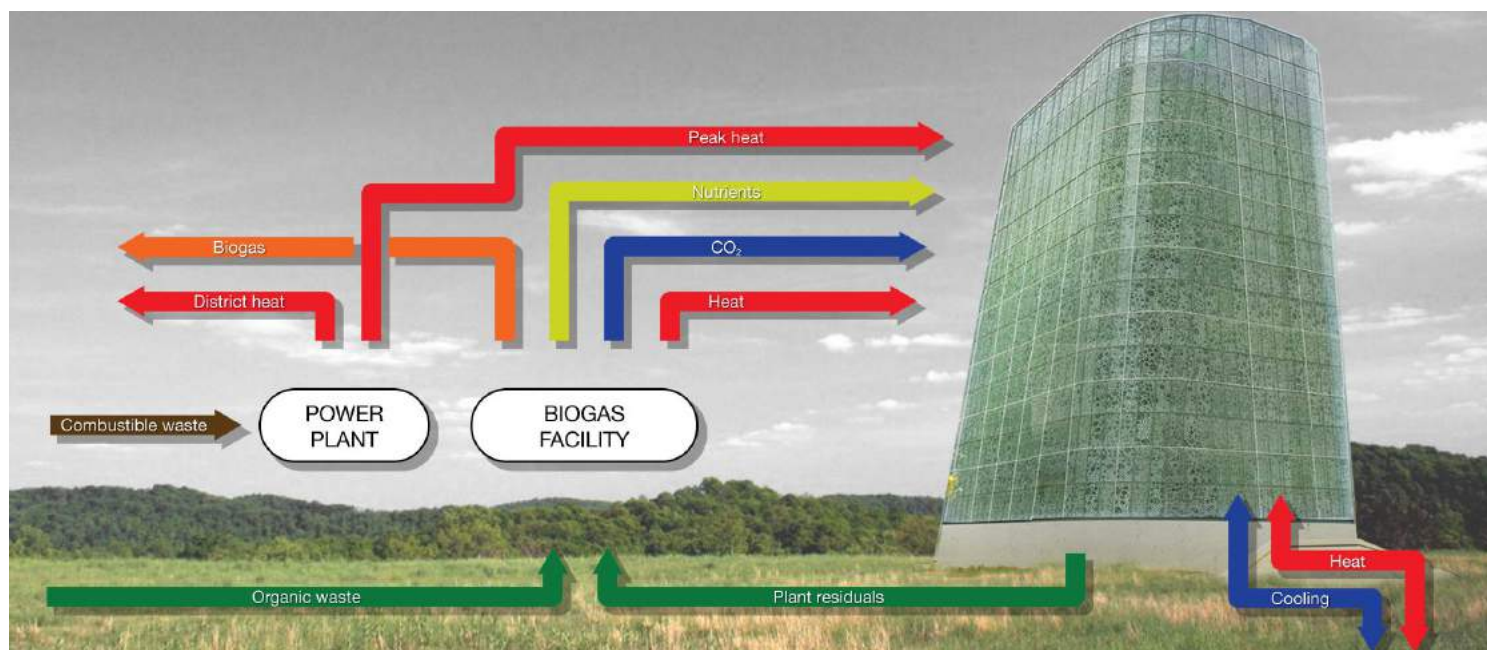
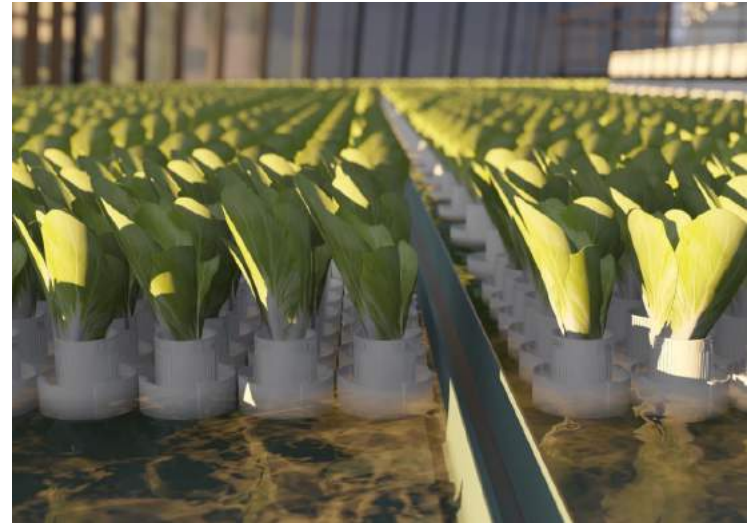
GROWING SPACE

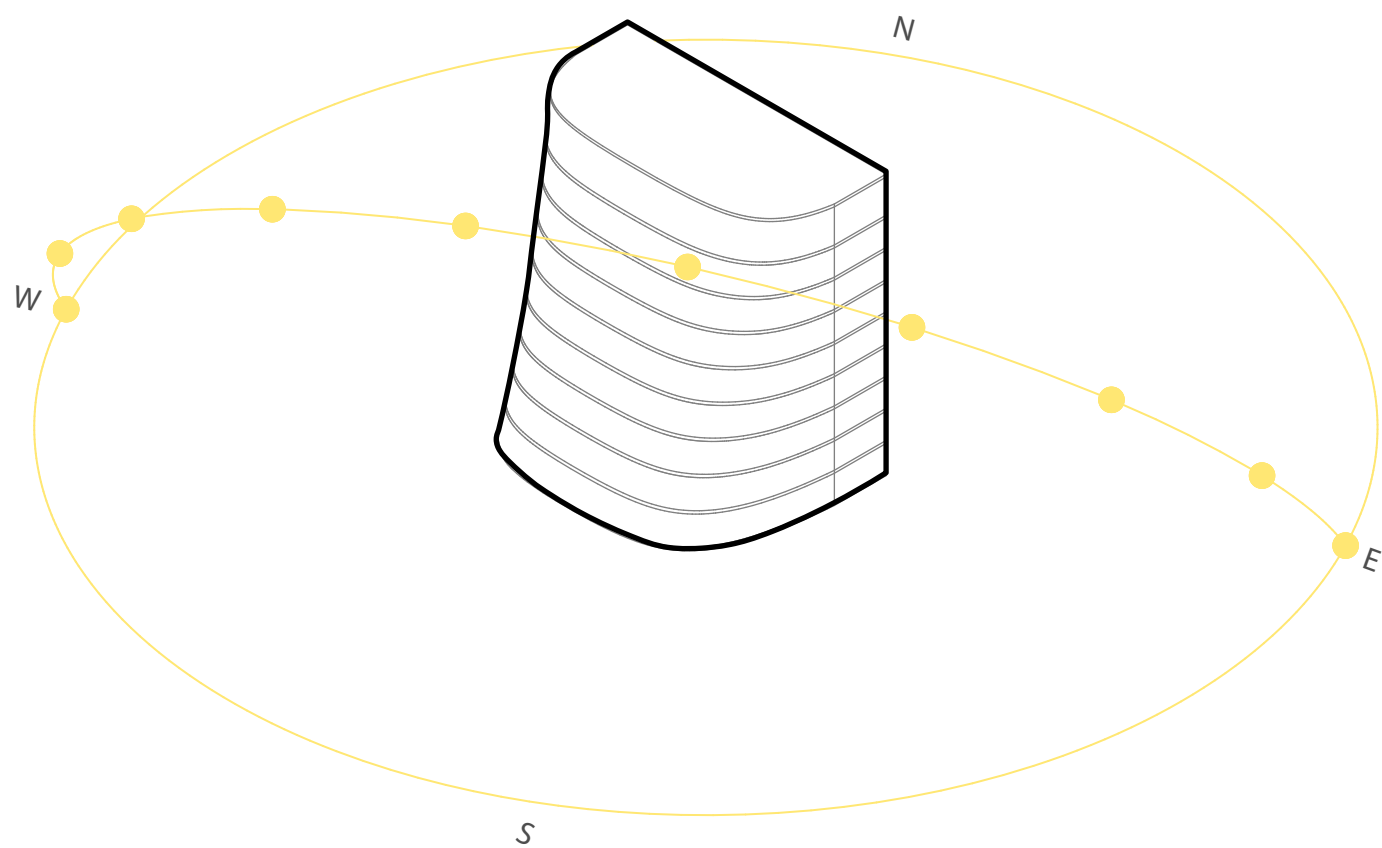


nodegroup00: Mean Daylight Autonomy = 94.08 % of  
time occupied

THE LINKOPING MODEL  
PLANTAGON





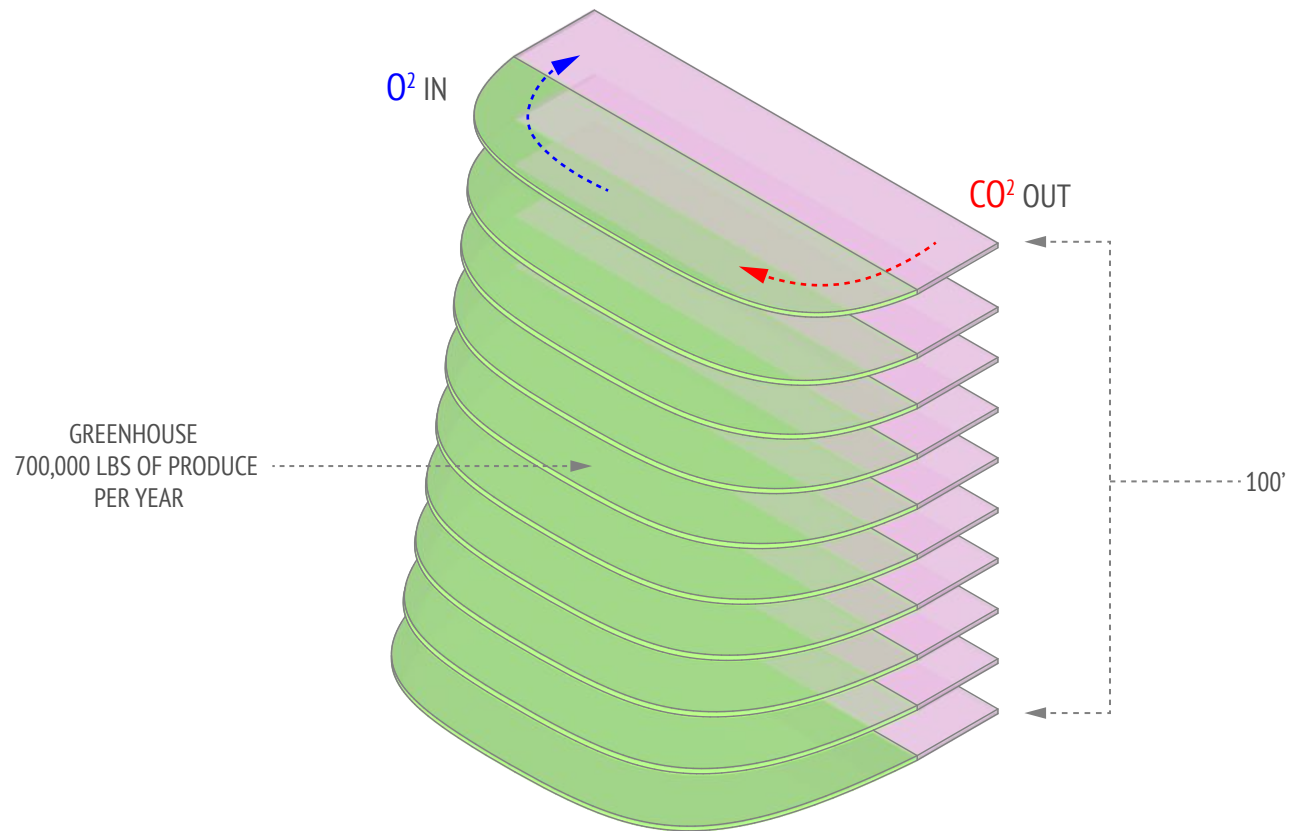


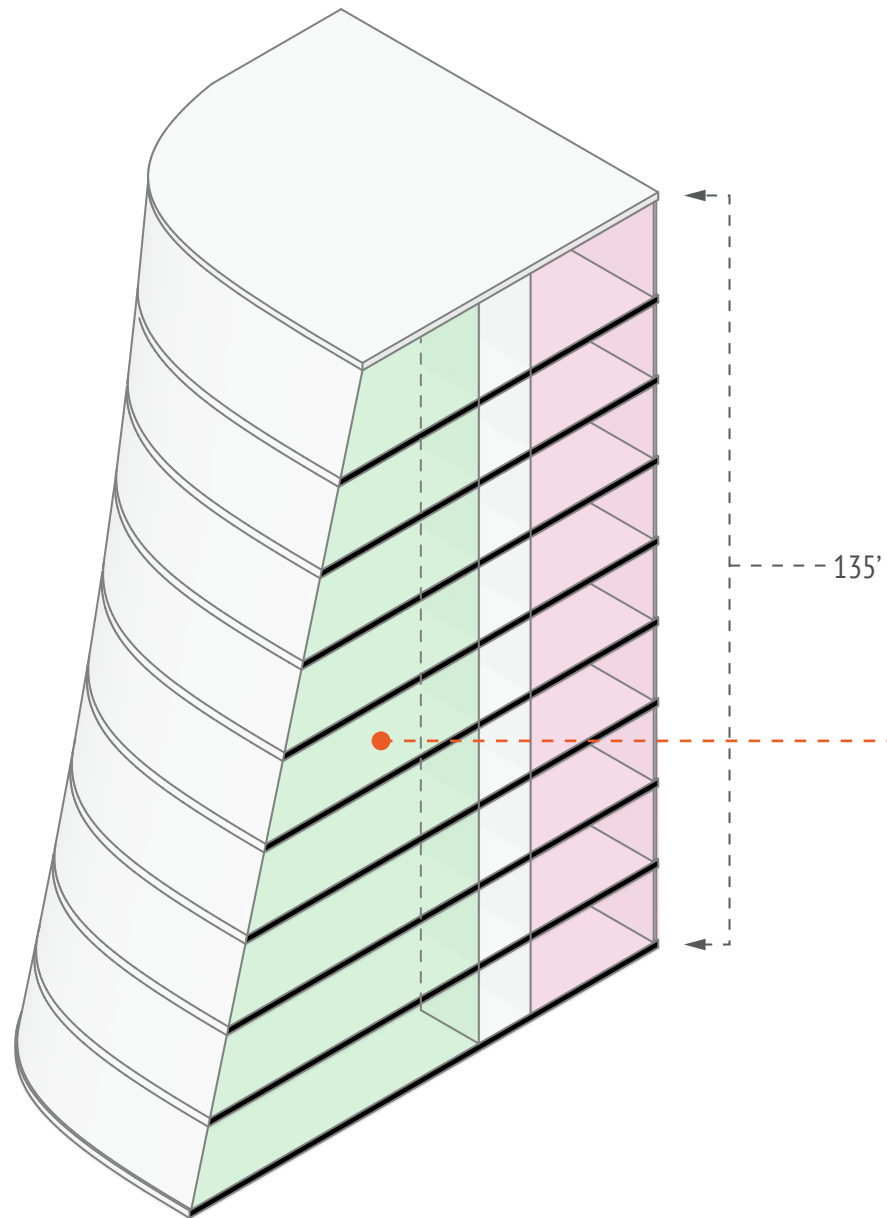


SOUTH FACING GREENHOUSE



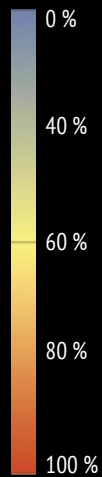
NORTH FACING OFFICES





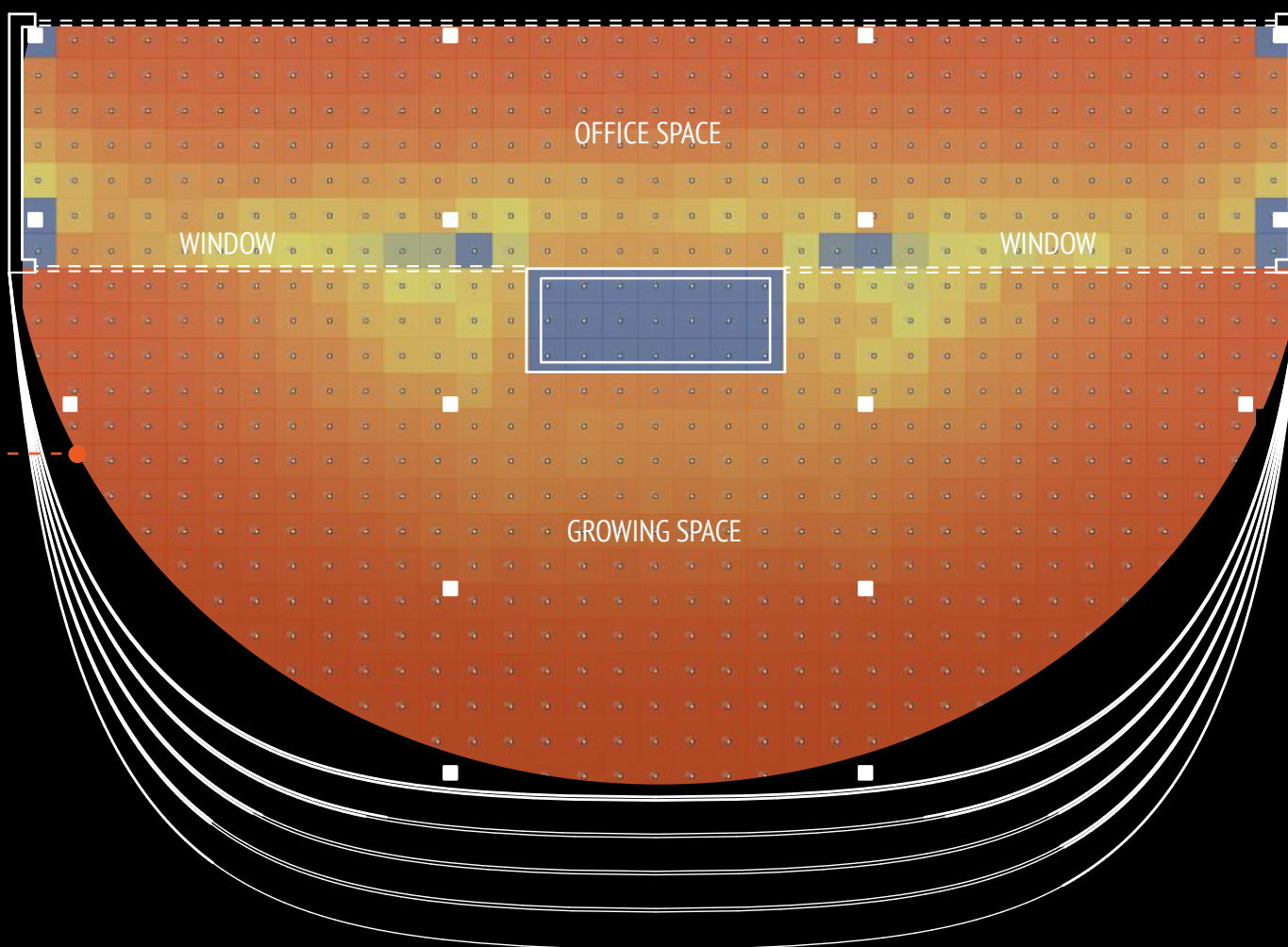


DAYLIT OCCUPIED HOURS  
PER YEAR



# DAYLIGHT AUTONOMY DISTRIBUTION PLANTAGON FLOOR PLAN STUDY

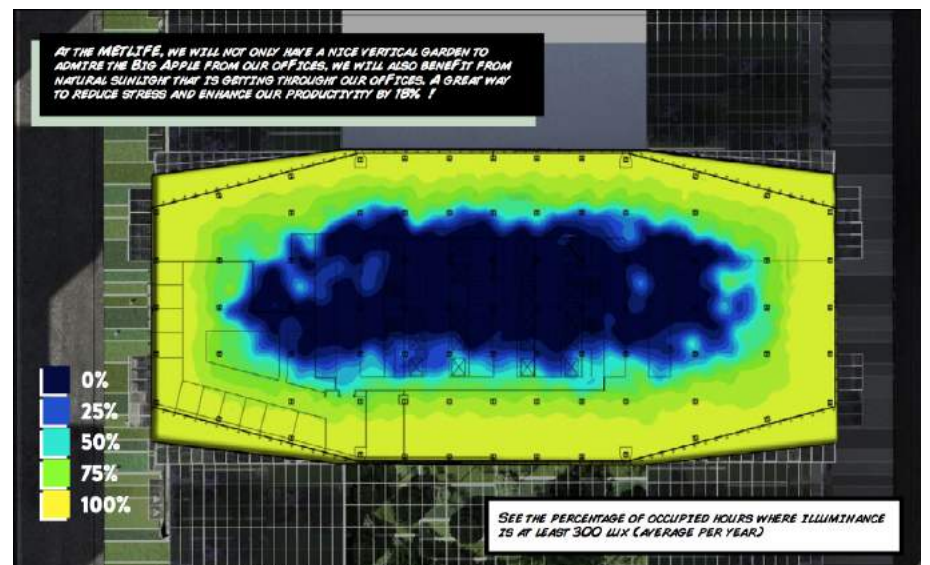
DAYLIGHT AREA ( DA 400 LUX (50%)  
(94%) OF FLOOR AREA  
MEAN DAYLIGHT FACTOR (7.8%)

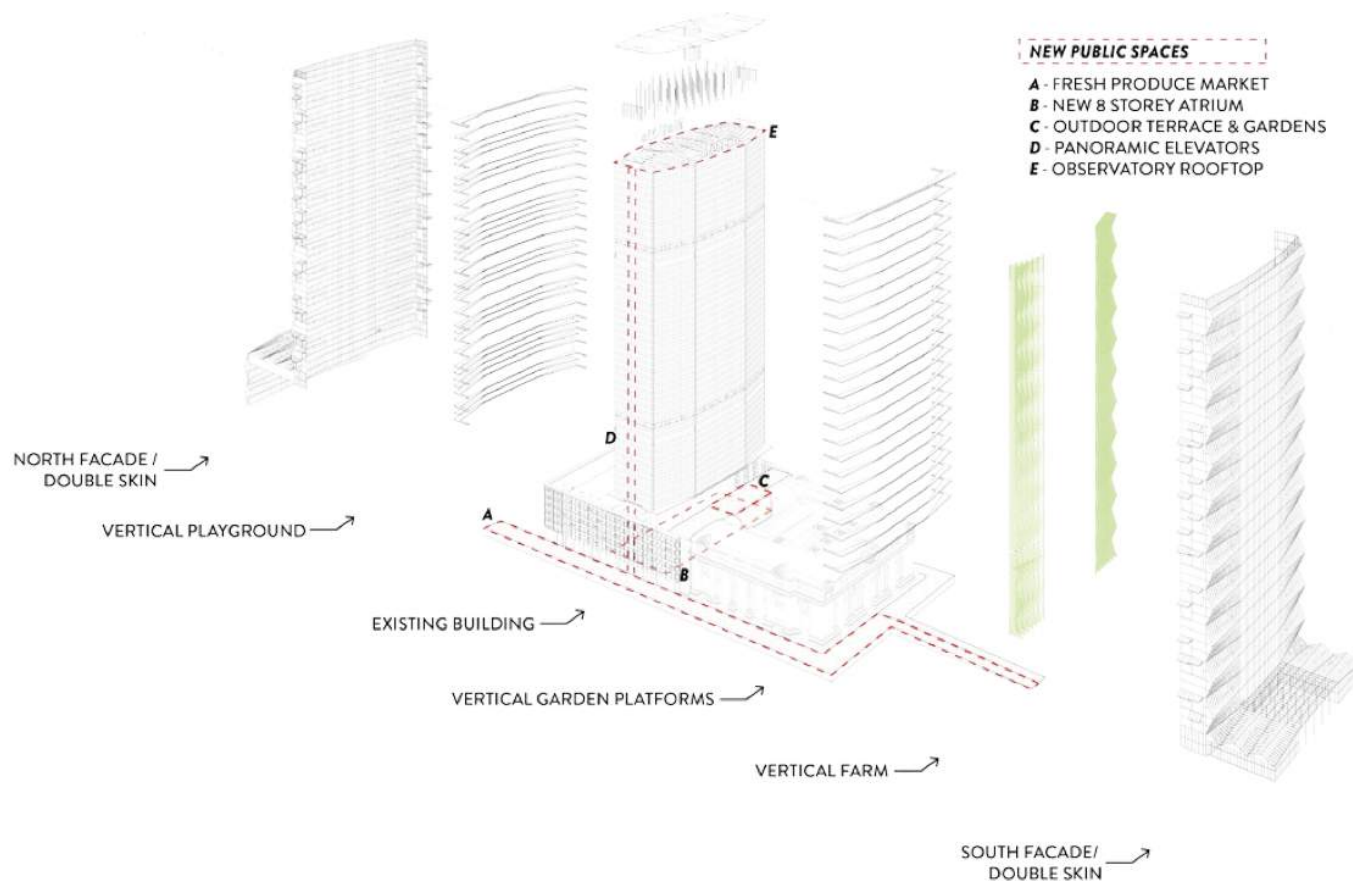




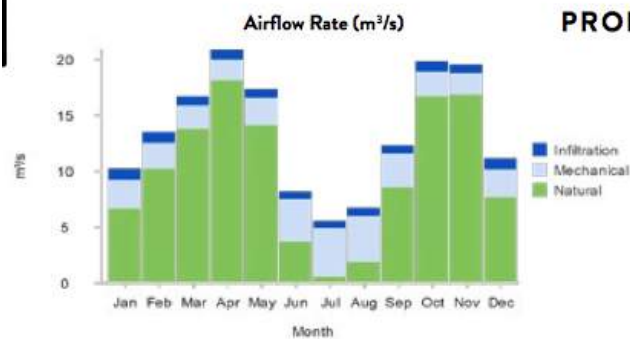
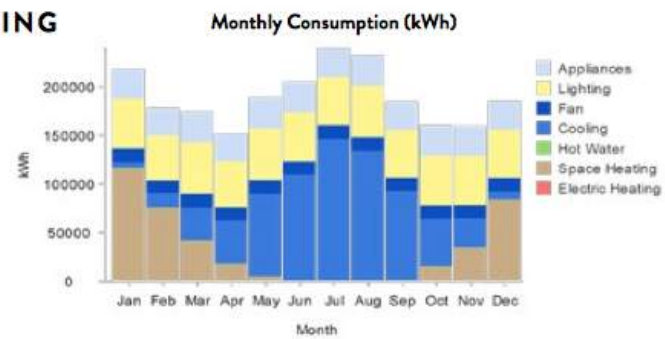
## FARM FOLLOWS FICTION : METLIFE FACADE RENOVATION

Lemay LAB, Ecosystem, and Sefaira

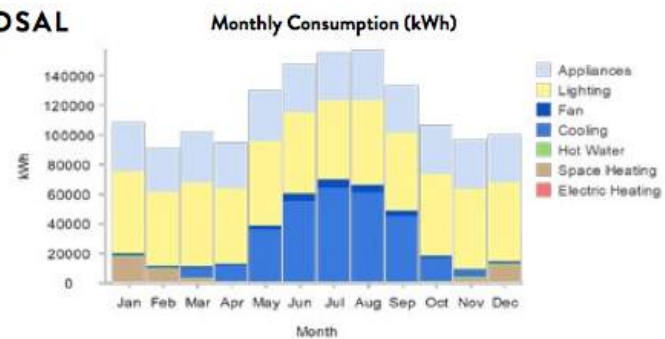


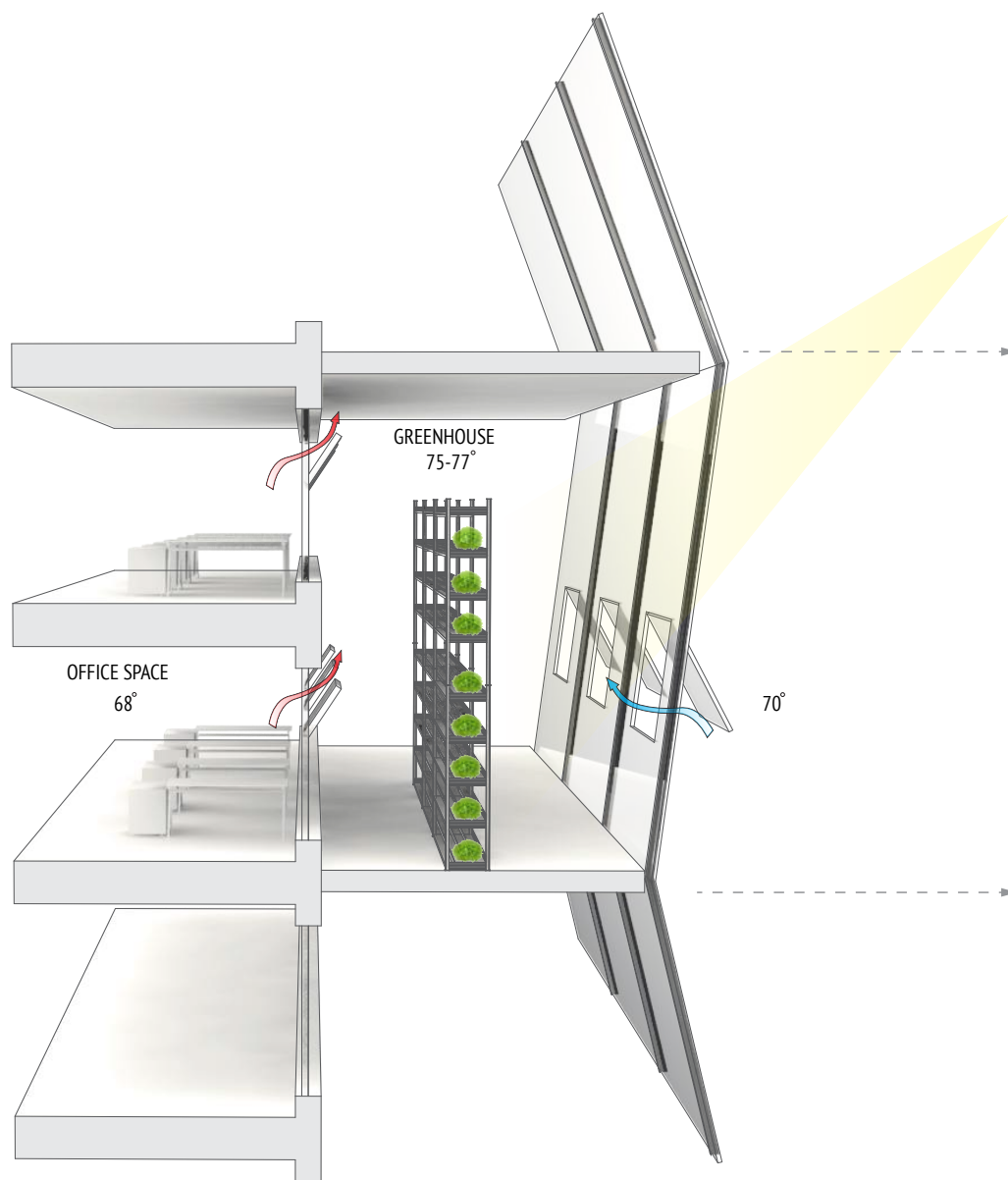


## EXISTING

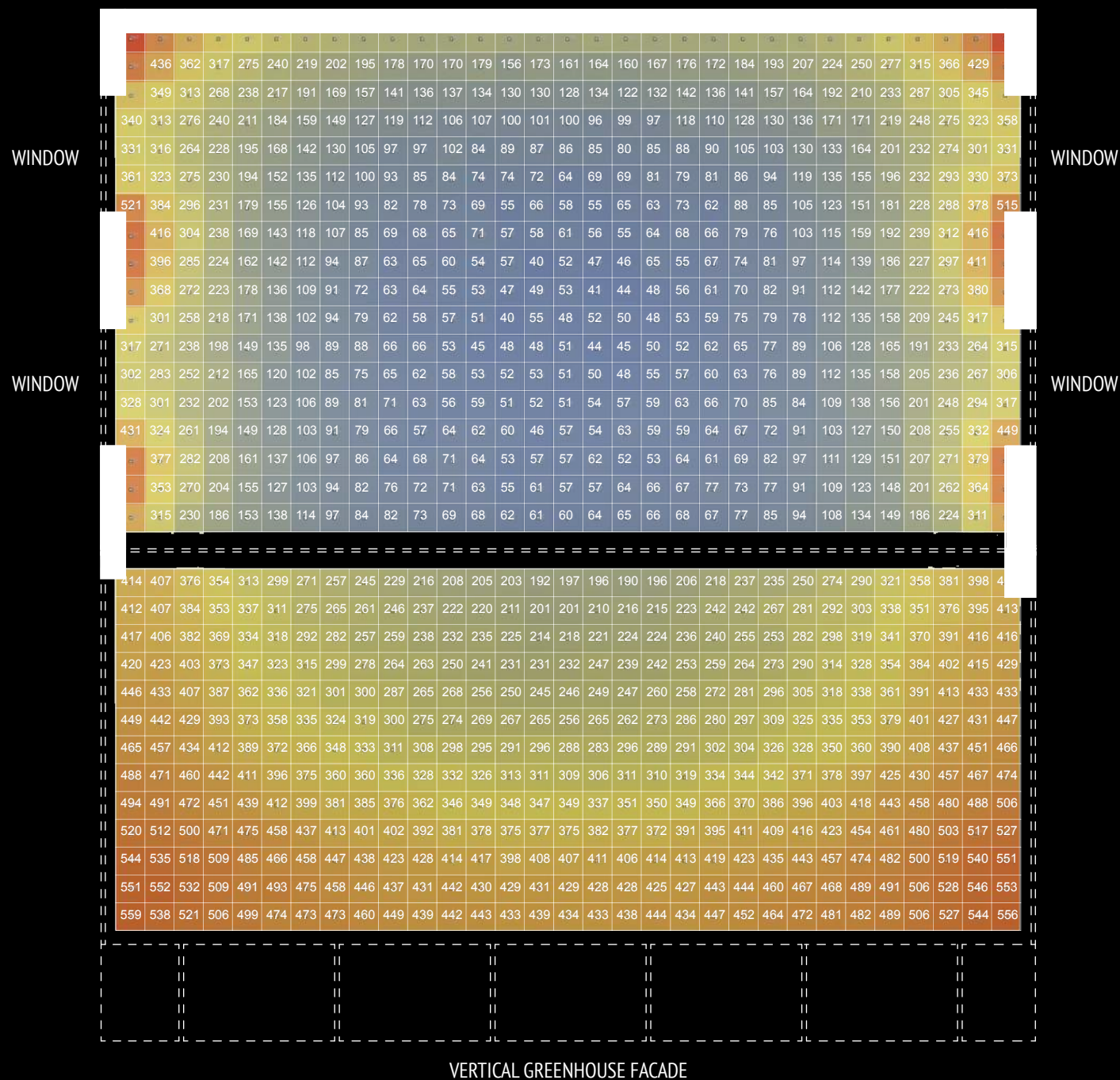


## PROPOSAL









## CASE | RENSSELAER | SOM SEWR

With increasing research and development regarding solar enclosure technologies, CASE has designed a water reclamation and thermal controlled facade that addresses water management systems for buildings. This system can clean and recycle water, provide thermal comfort, and contribute to a buildings water storage. The research team states that “Dynamic building water cycles present opportunity to analyze the potential for water-savings through intervention of architectural form and through the integration of multiple systems aiding the conservation of potable and non-potable water” (CASE | Center for Architecture and Ecology).

If this system is applied to an urban vertical farm we can potentially provide clean water for plants and building occupants. Additionally, thermal comfort is achieved creating low operation costs.



FIG. XX <http://www.case.rpi.edu/page/project.php?pageid=4>



FIG. XX <http://www.case.rpi.edu/page/project.php?pageid=4>



FIG. XX <http://www.case.rpi.edu/page/project.php?pageid=4>



CASE | RENSSELAER | SOM  
ACTIVE BIOREMEDIATION SYSTEMS

Plants have the ability to physically clean pollutants in the air while supplying fresh oxygen to our environment. Contemporary building materials have contributed to a rise in negative emissions when producing them and poor indoor air quality.

CASE states that “by integrally cleaning airborne contaminants associated with poor indoor air quality, building-integrated active phytoremediation systems have the potential to decrease or even eliminate fresh air requirements required by American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), and with that the potential to both realize substantial energy savings in climate types with high heating and/or cooling loads and to reduce or eliminate the need to intake, treat and circulate poor quality air in heavily polluted urban areas” (CASE | Center for Architecture and Ecology).



FIG. XX <http://www.case.rpi.edu/page/project.php?pageid=3>



FIG. XX <http://www.case.rpi.edu/page/project.php?pageid=3>

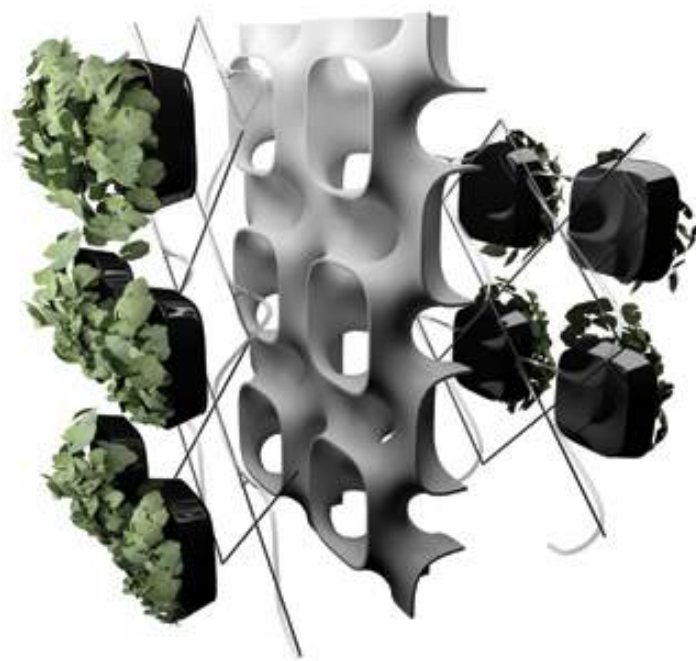
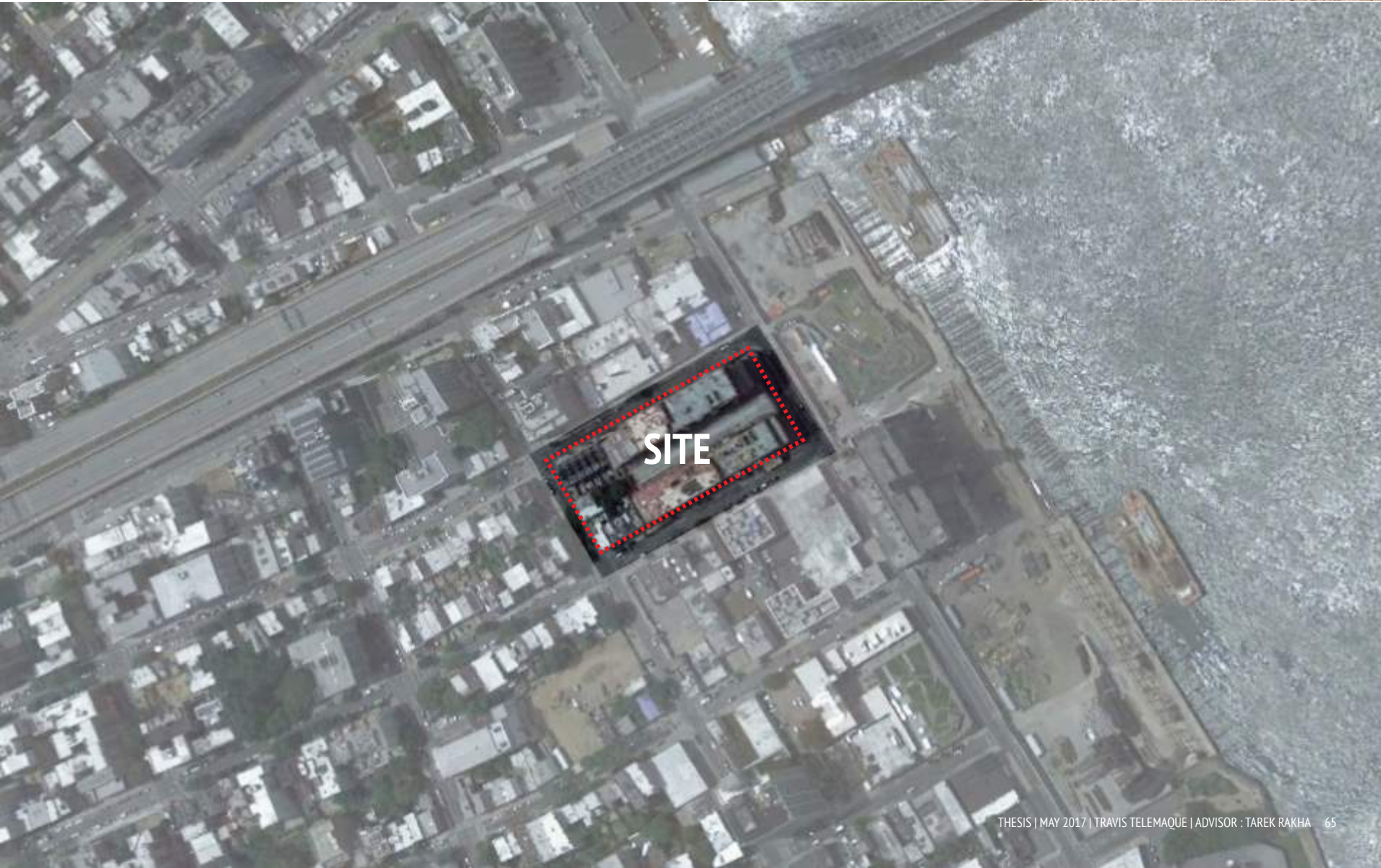


FIG. XX <http://www.case.rpi.edu/page/project.php?pageid=3>











# THE INDUSTRIAL WATERFRONT

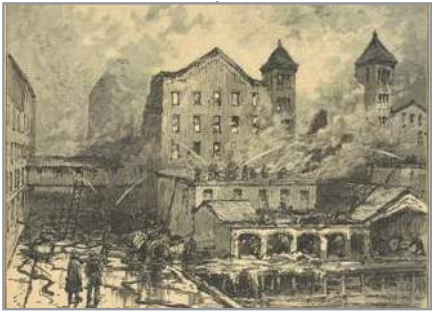
The Domino Sugar Factory in Williamsburg Brooklyn was once one of the leading sugar manufacturers in all of the United States. The community prospered as the waterfront became a major sugar exporting port and jobs were created. “The East River waterfront became extremely active as raw goods, such as sugar cane came from Cuba, Brazil and other countries was being brought in by ships and refined sugar was being shipped out.” For years Domino Sugar celebrated tremendous success until 1988 when food advocates stated that refined sugar was not healthy and began promoting sugar alternatives. The factory later shut down its operations in 2004 after a hard fought employee strike. What stands today is a reminder of the once booming industrial sugar age of Williamsburg.

1816  
Havemeyer Corporation is founded by William and Fredrick Havemeyer



1821  
New York industrial waterfront boom

1858  
Fredrick Havemeyer purchases property on Williamsburgs waterfront



1882  
A fire destroys Havemeyer Sugar Refinery

1920  
Domino Sugar Refinery is established  
Williamsburg becomes one of the nations leading sugar exporters



1917  
Havemeyer constructs the American Sugar Refinery making the waterfront more efficient

# NEW DOMINO DEVELOPMENT

What was once the Domino Sugar refinery is now becoming Brooklyn's newest neighborhood. The proposal calls for the preservation of the site's refinery building with the construction of four new residential towers around it. Out of the 2,200 apartments proposed, half of them will be affordable for the poor and working class. "We're taking this narrow, vacant industrial site and turning it into an incredibly powerful economic engine for the neighborhood," said the developer, Michael Lippin, president of the Community Preservation Corporation. Well what if an urban farm was the machine that drove the neighborhood? The urban farm will act as a grocery store for the neighboring residential towers and surrounding area. The idea is that if you design an urban farm within large urban developments, people will benefit from local food production and learn how to harvest their own crops through a community garden education center.

2015  
Two Trees Development

This proposal will overshadow the surrounding neighborhood with high rise luxury apartments some of which are affordable. The site has great solar potential but is being traded off for what the developers requested.



2004  
Domino Sugar Refinery closes



2001  
Strike ends



1999  
Domino Sugar Employees go on strike



2010  
Domino Sugar Redevelopment

Why not an urban vertical farm?

## NYC FOOD OUTLETS AND OPERATIONS

The food system for New York City is not fully secure. Our current method of producing and distributing food is inefficient and wasteful. “Moreover, New York City is not fully capitalizing on its economic power to create good jobs and economic opportunity at each phase of the food system”(Foodworks).



**24,000** RESTAURANTS



**5,500** GROCERY STORES



**1,750** FOOD WHOLESALERS



**1,500** PUBLIC SCHOOLS



**1,000** EMERGENCY FEED PROGRAMS



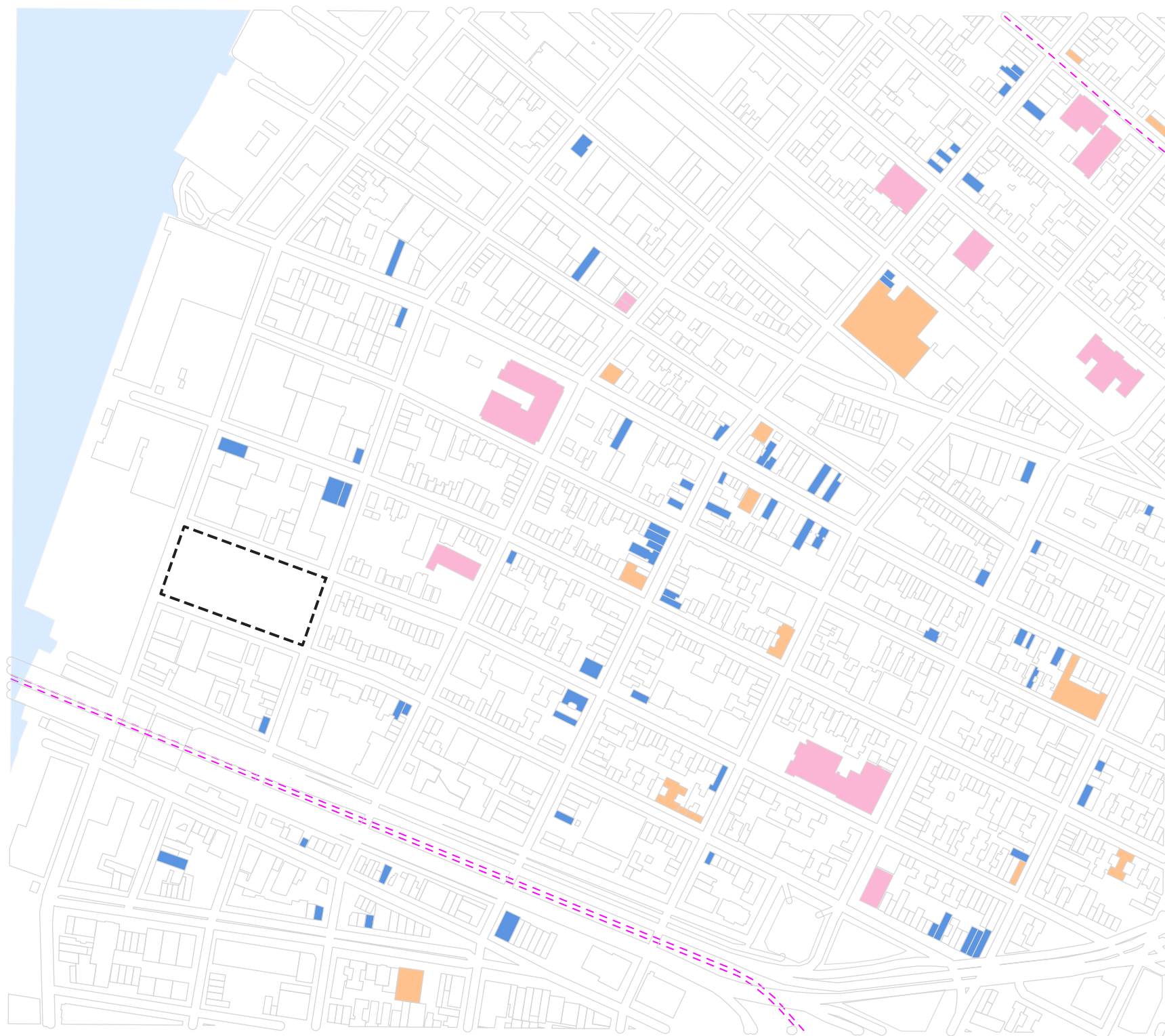
**1,000** FOOD & BEVERAGE MANUFACTURERS



**445** GREEN CARTS

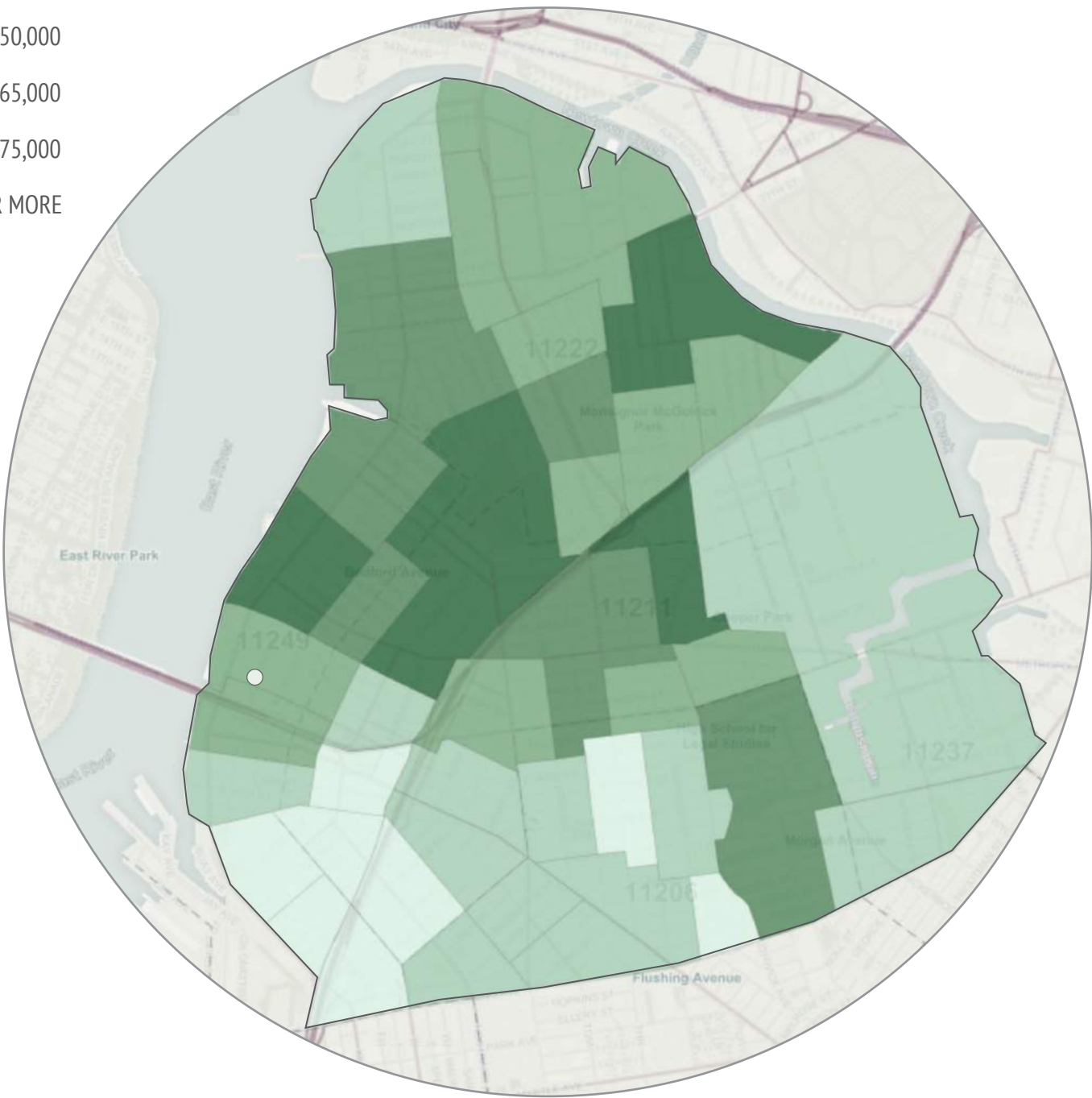


**120** FARMERS MARKETS



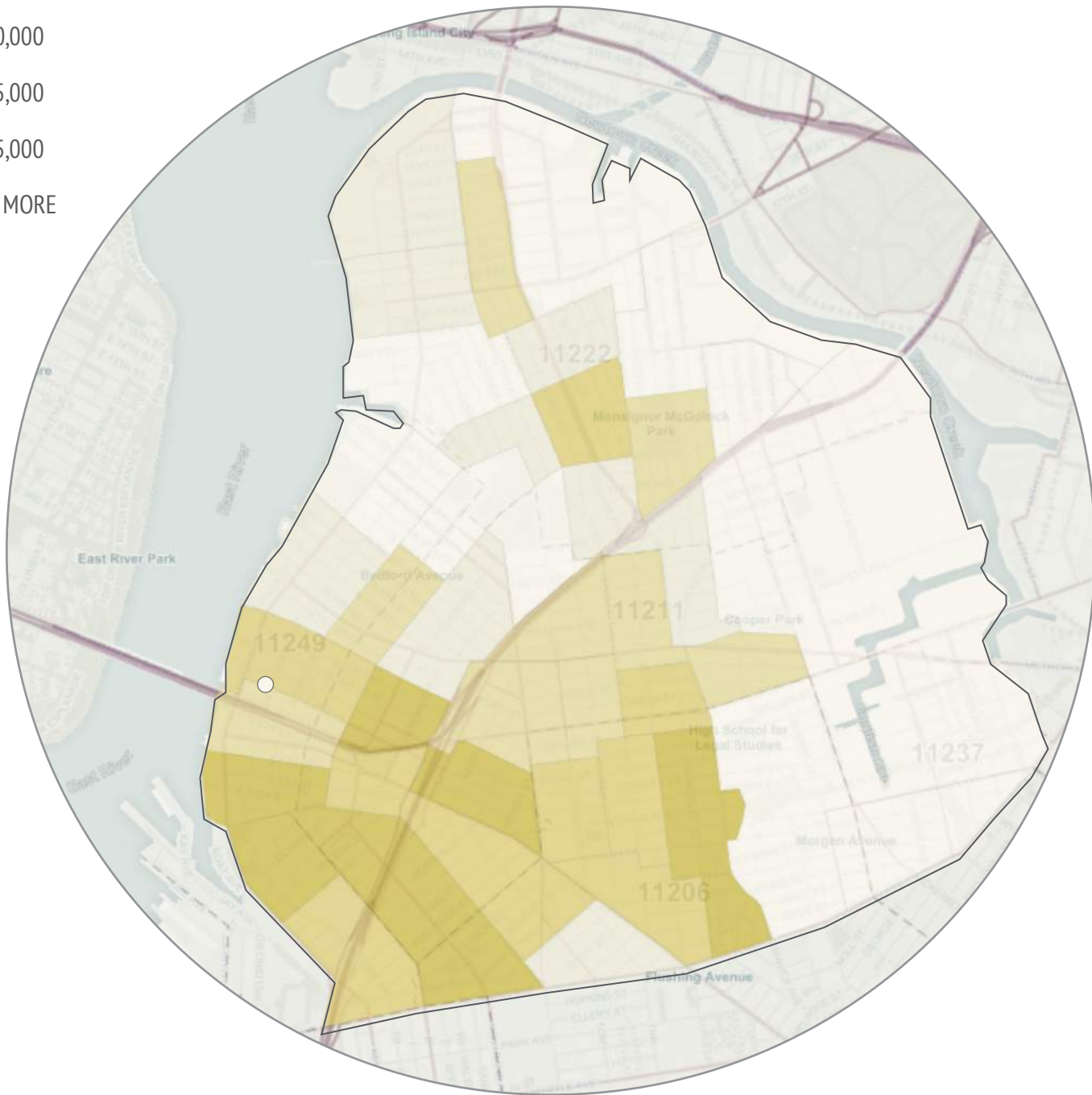
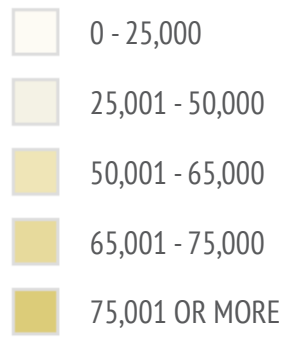
MEDIAN HOUSEHOLD INCOME

- 0 - \$25,000
- \$25,001 - \$50,000
- \$50,001 - \$65,000
- \$65,001 - \$75,000
- \$75,001 OR MORE





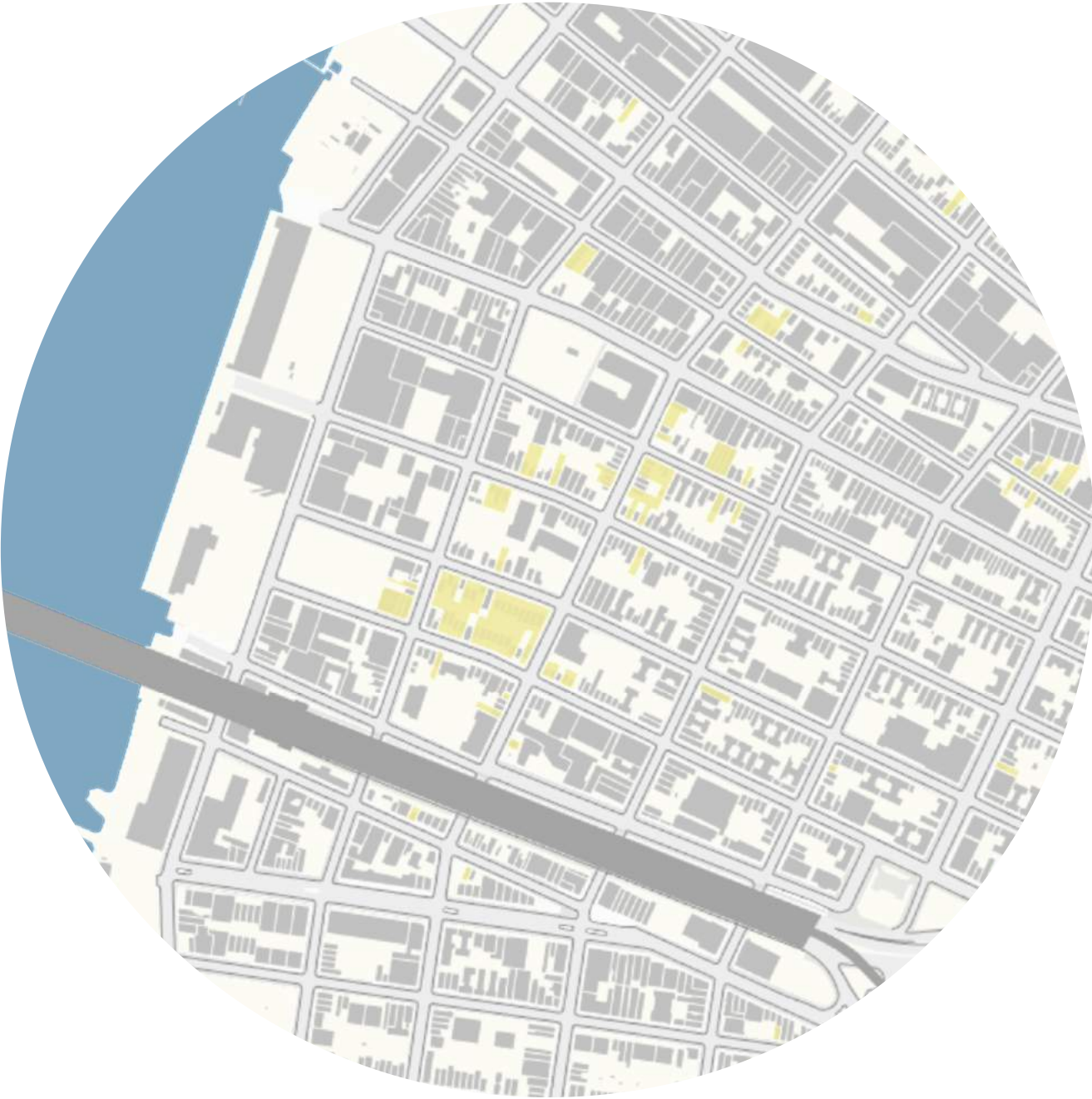
# POPULATION DENSITY







1 & 2 FAMILY RESIDENTIAL





MULTI-FAMILY RESIDENTIAL





 MIXED USE



INDUSTRIAL SITES





## CONNECTING COLLECTION

The urban vertical farm will act as a organic drop-off site for 40 plus food scrap collectors within the five boroughs. In turn the scraps will be composted and turn into soil for plants, or placed in a bioreactor for fuel.





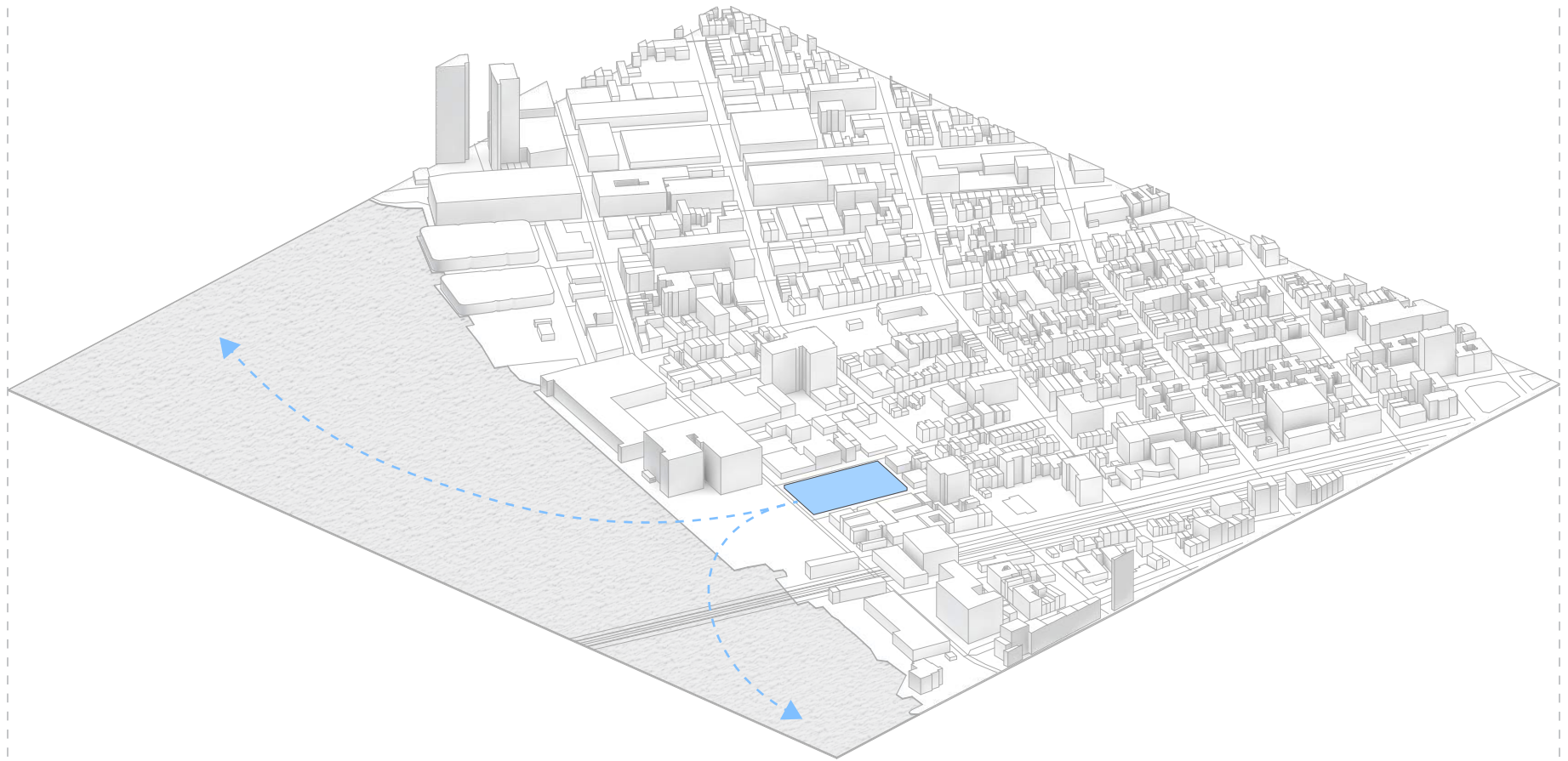




SITE



EAST RIVER SHIPPING ROUTES / FERRY ROUTES





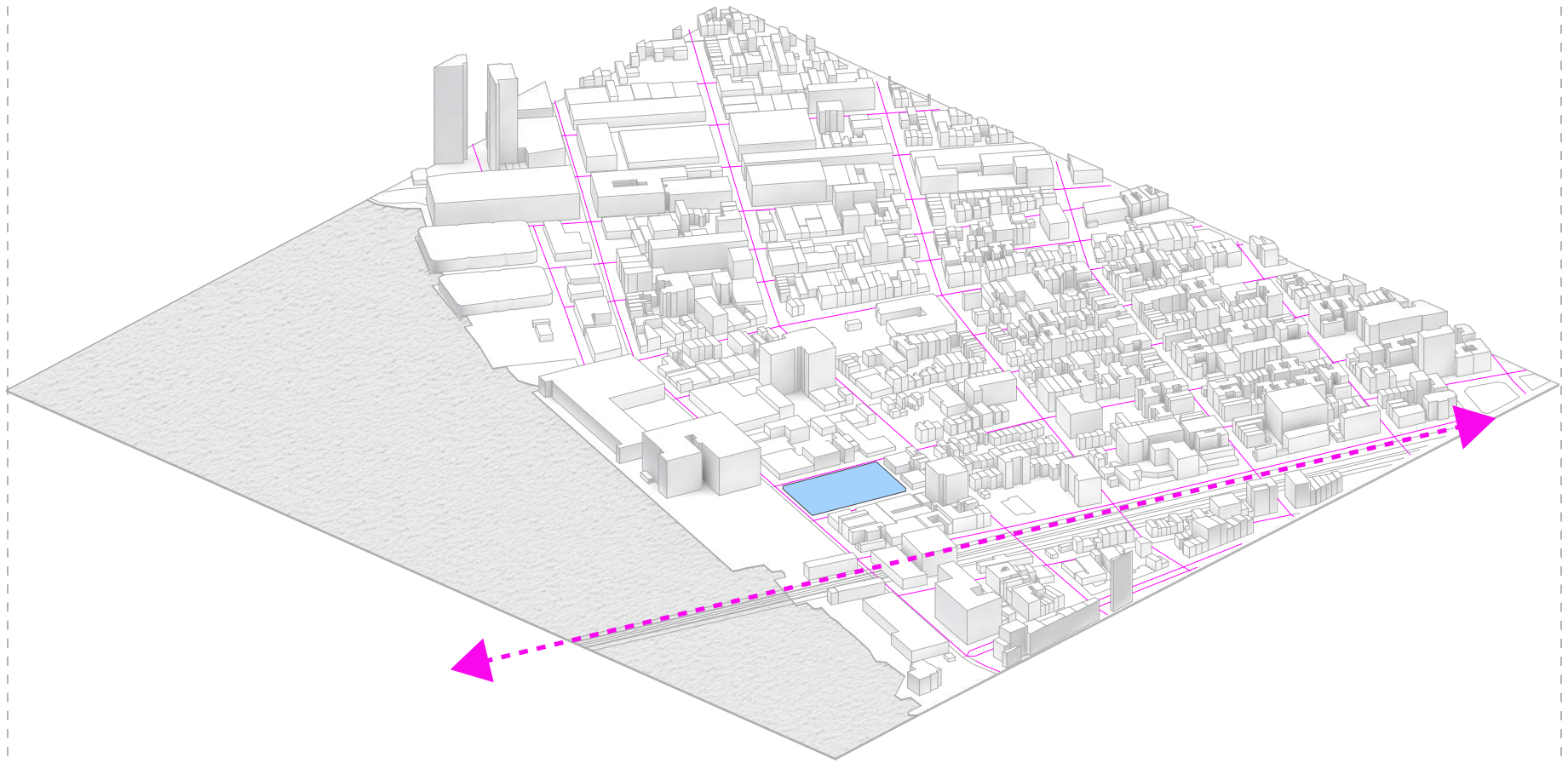
SITE



PRIMARY TRANSPORT ROUTES : WILLIAMSBURG BRIDGE / HWY 278



SECONDARY STREETS



# NEW YORK CITY ZONING AND LAND USE

BOROUGH : BROOKLYN

BLOCK : 2428

LOT : 1

ZONING : R6

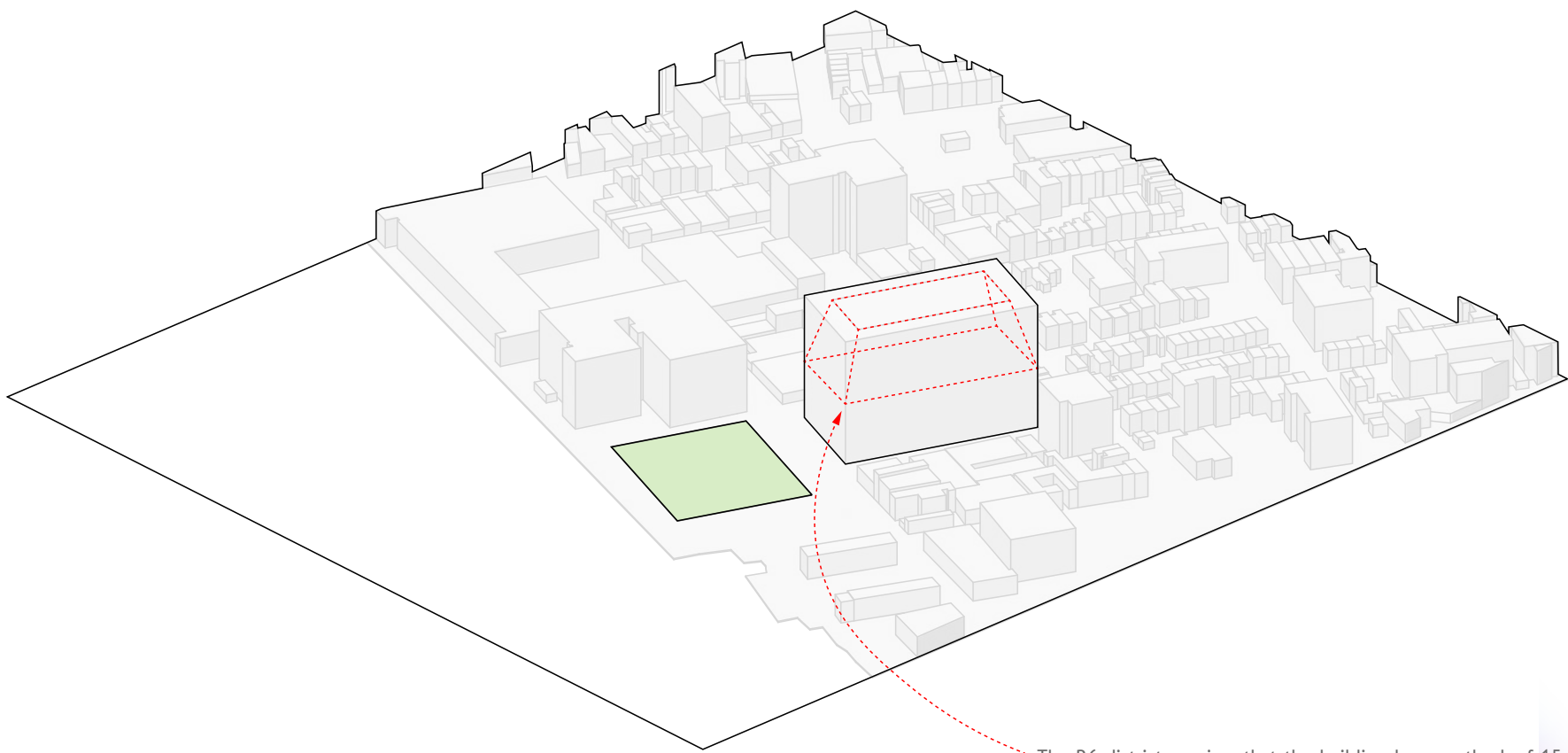
COMMERCIAL OVERLAY : C2-4

ZONING MAP : 12D

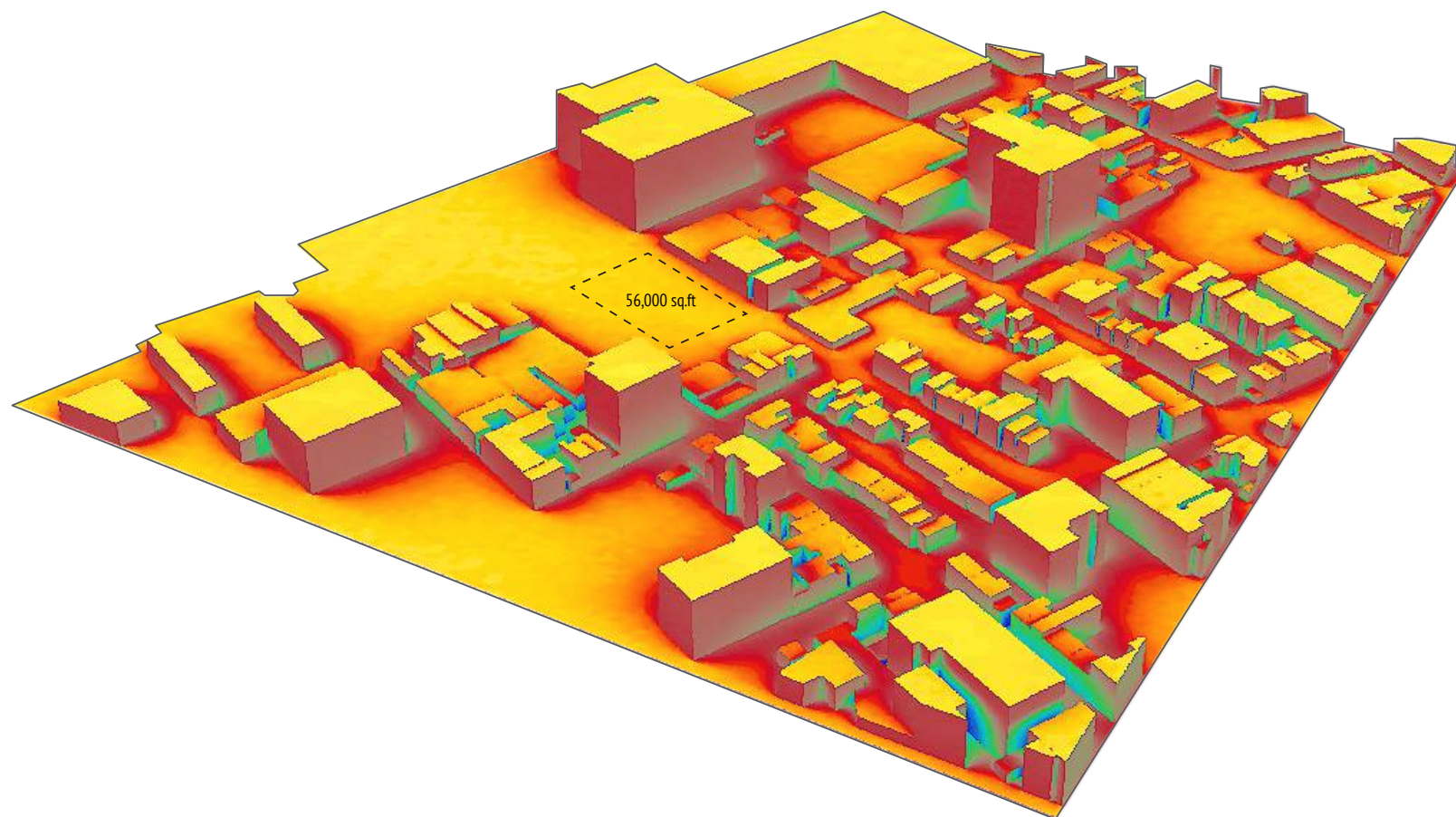
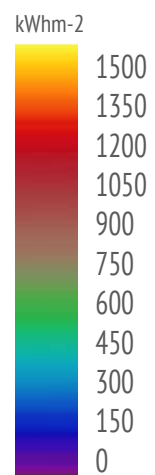
HISTORIC ZONING MAPS : 12D

The character of R6 districts can range from neighborhoods with a diverse mix of building types and heights to large-scale “tower in the park” developments such as Ravenswood in Queens and

C1-1 through C1-5 and C2-1 through C2-5 districts are commercial overlays mapped within residence districts. Mapped along streets that serve local retail needs, they are found extensively throughout the city’s lower- and medium-density areas and



The R6 district requires that the building has a setback of 15 degrees once it surpasses 60 feet.



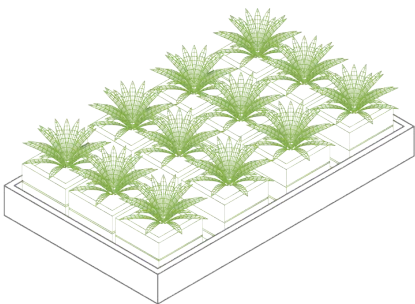


WILLIAMSBURG COMMUNITY GARDENS

PLANTING BEDS

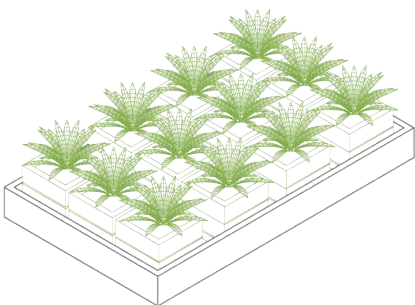
TOTAL

KEAP FOURTH COMMUNITY GARDEN  
347 KEAP STREET BROOKLYN  
2,900 SQ FT  
COMMUNITY DEVELOPMENT GRANT : YES  
FOOD PRODUCTION : YES



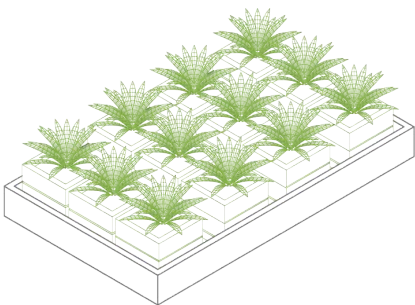
8

BERRY STREET GARDEN  
303 BERRY STREET BROOKLYN  
5,946 SQ FT  
COMMUNITY DEVELOPMENT GRANT : YES  
FOOD PRODUCTION : YES



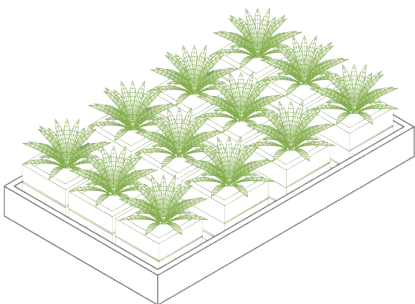
14

NORTHSIDE COMMUNITY GARDEN  
599 DRIGGS AVENUE BROOKLYN  
1,572 SQ FT  
COMMUNITY DEVELOPMENT GRANT : NO  
FOOD PRODUCTION : YES



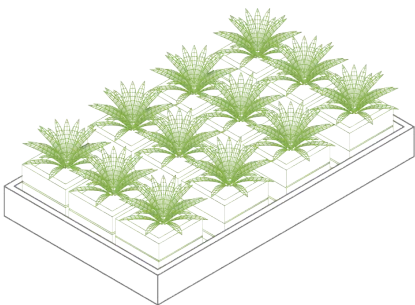
4

GRANT STREET COMMUNITY GARDEN  
239 GRAND STREET BROOKLYN  
1,992 SQ FT  
COMMUNITY DEVELOPMENT GRANT : NO  
FOOD PRODUCTION : YES



6

EL PUENTE EARTH SPIRIT GARDEN  
203-207 SOUTH STREET BROOKLYN  
10,363 SQ FT  
COMMUNITY DEVELOPMENT GRANT : NO  
FOOD PRODUCTION : YES



25

WEST FACADE :  
32,400 SQ FT

SOUTH FACADE :  
57,600 SQ FT

ROOF TOP :  
57,600 SQ FT

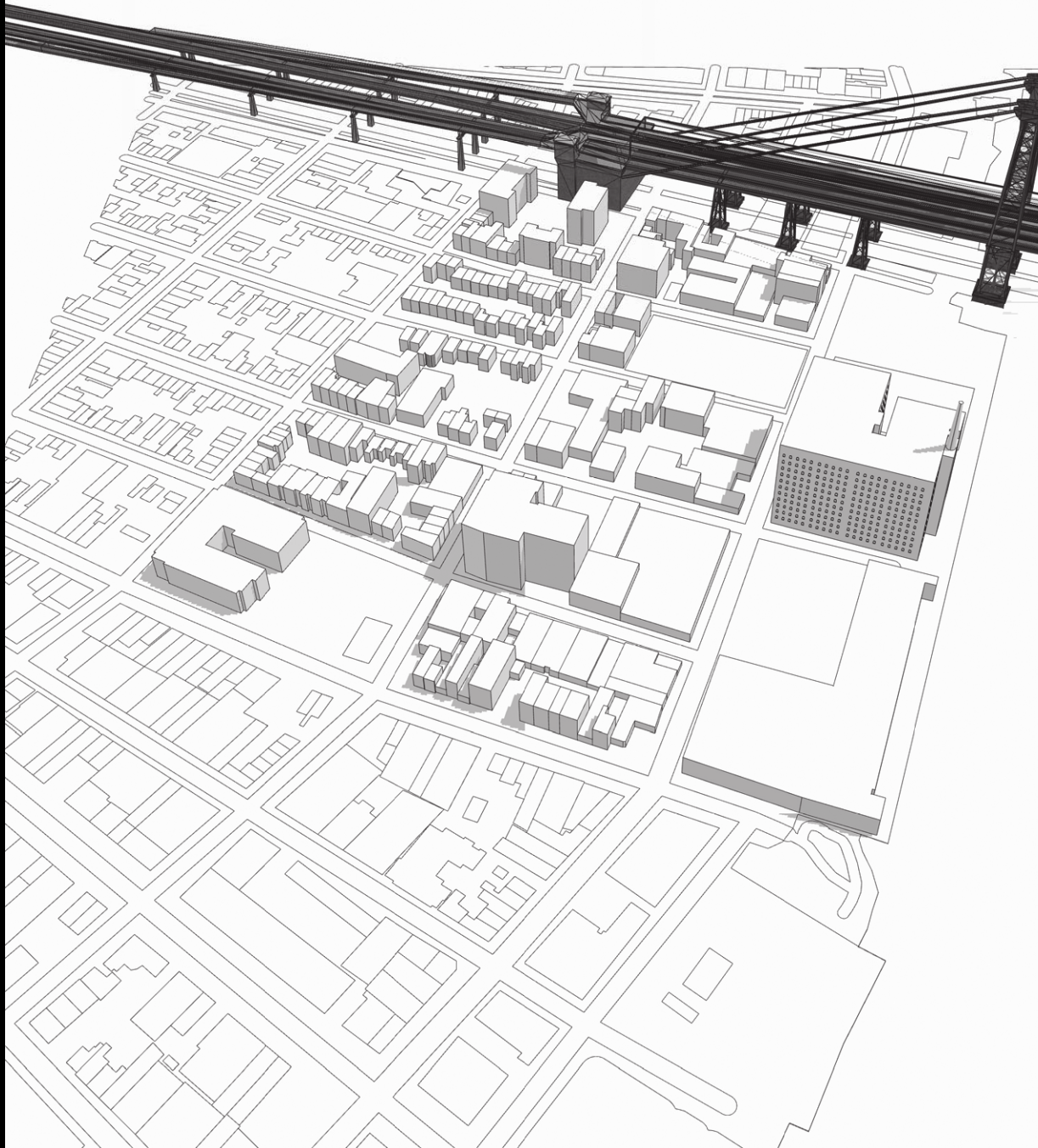
WATERFRONT GARDEN :  
50,000 SQ FT



MARCH 21ST AT 2:00PM

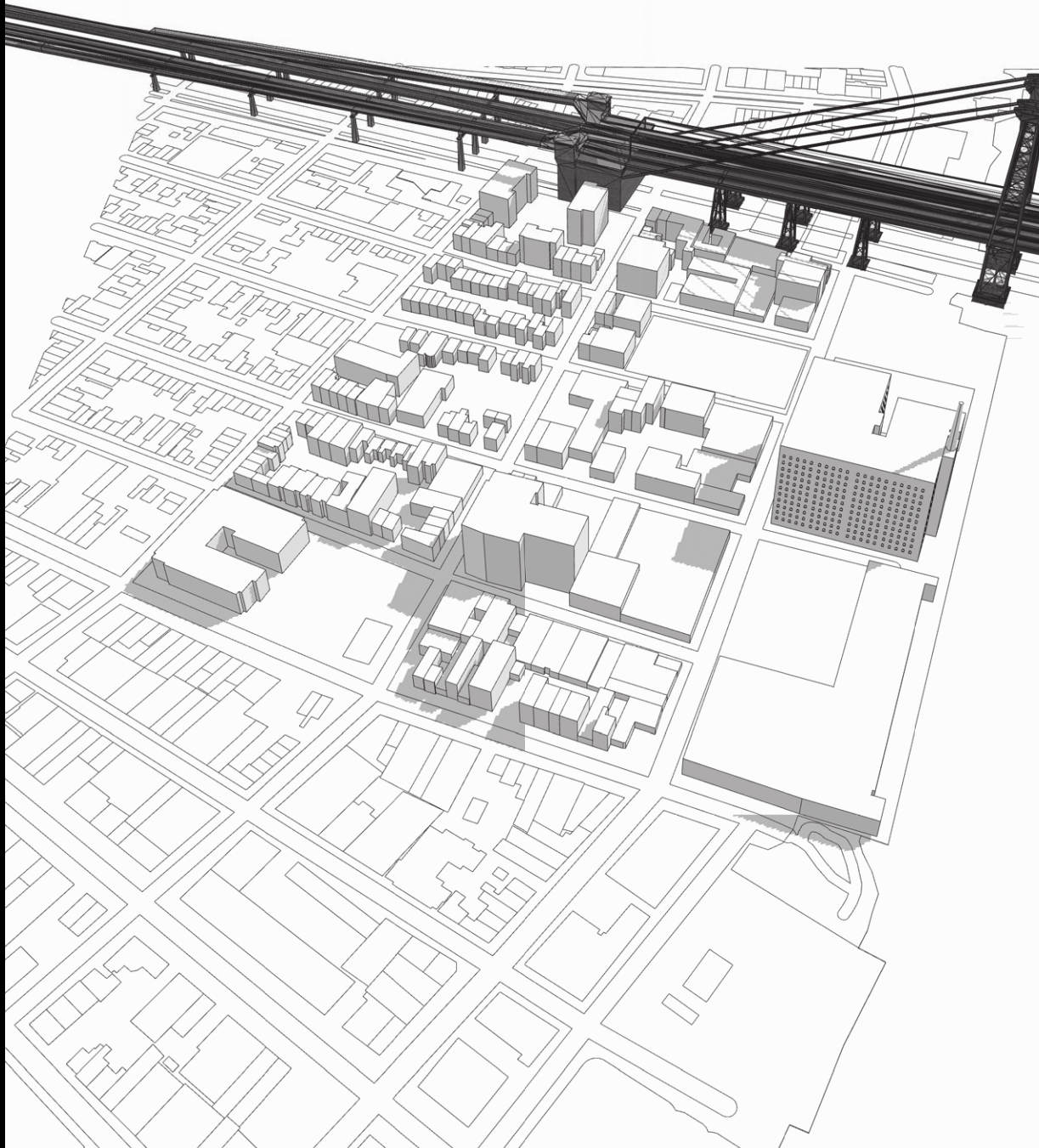


JUNE 21ST AT 2:00PM

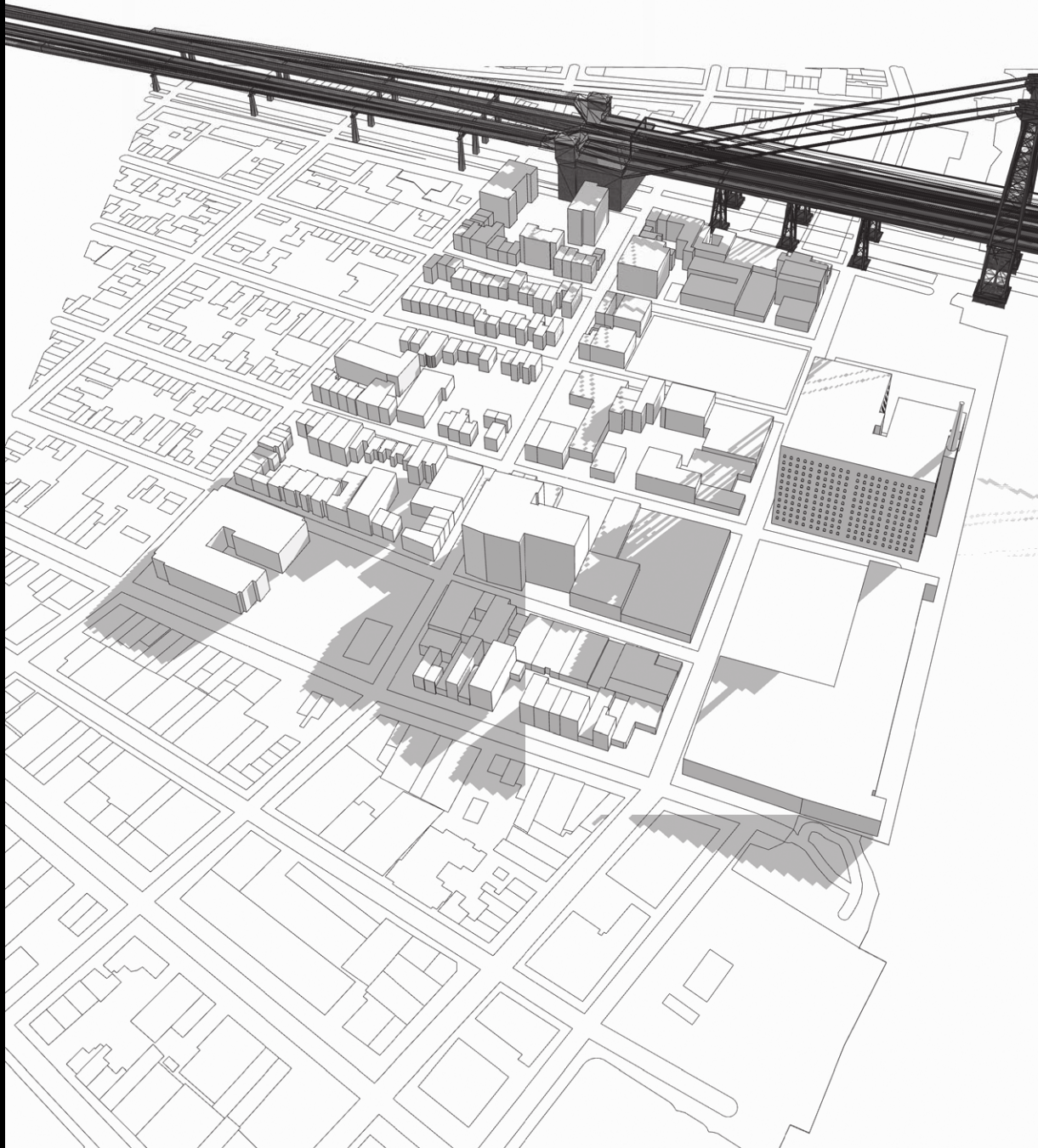




SEPTEMBER 21ST AT 2:00PM

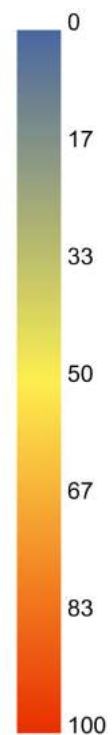


DECEMBER 21ST AT 2:00PM





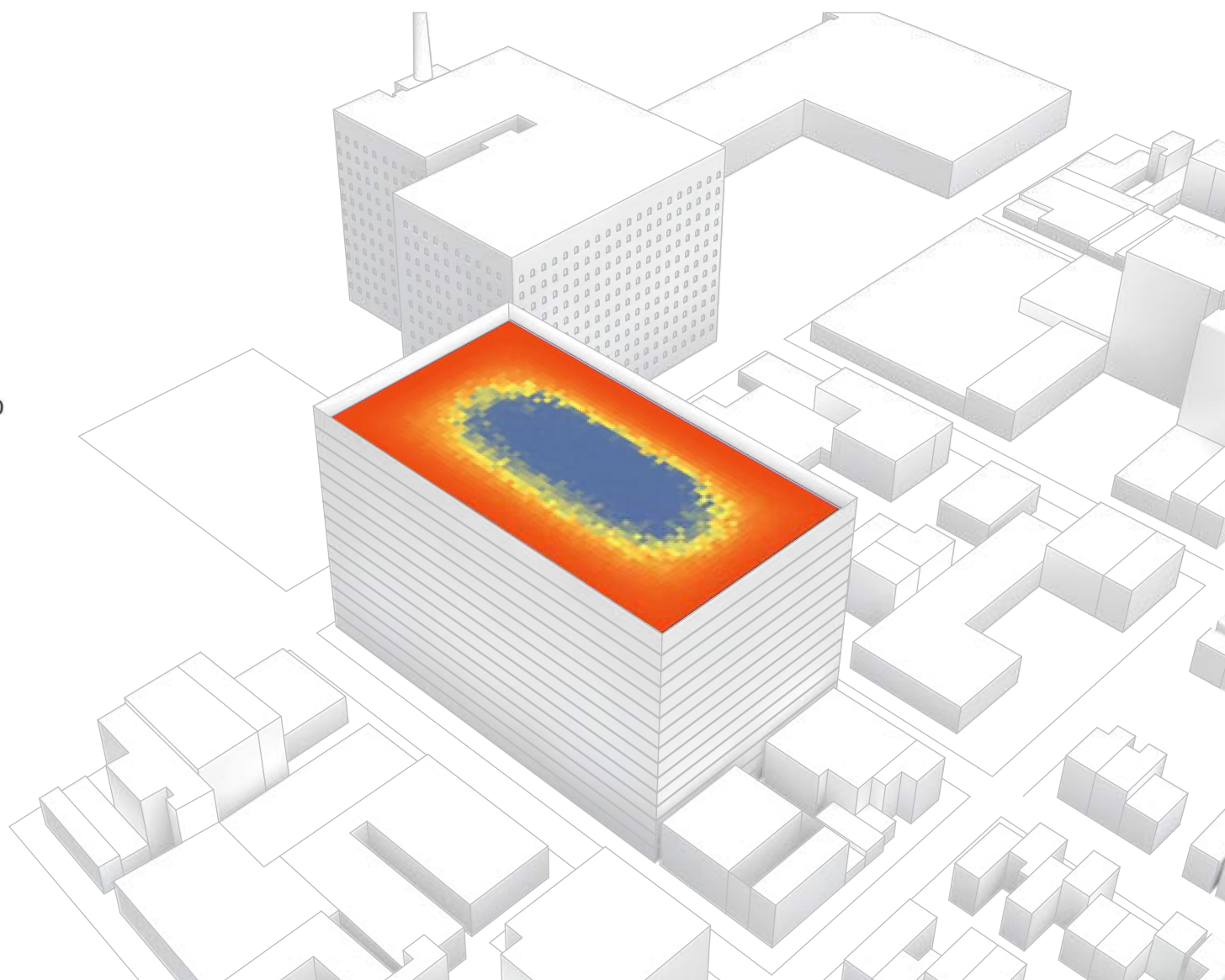
% OCCUPIED HOURS



DAYLIT AREA ( DA 300LUX (50%) ) : 70% OF FLOOR AREA

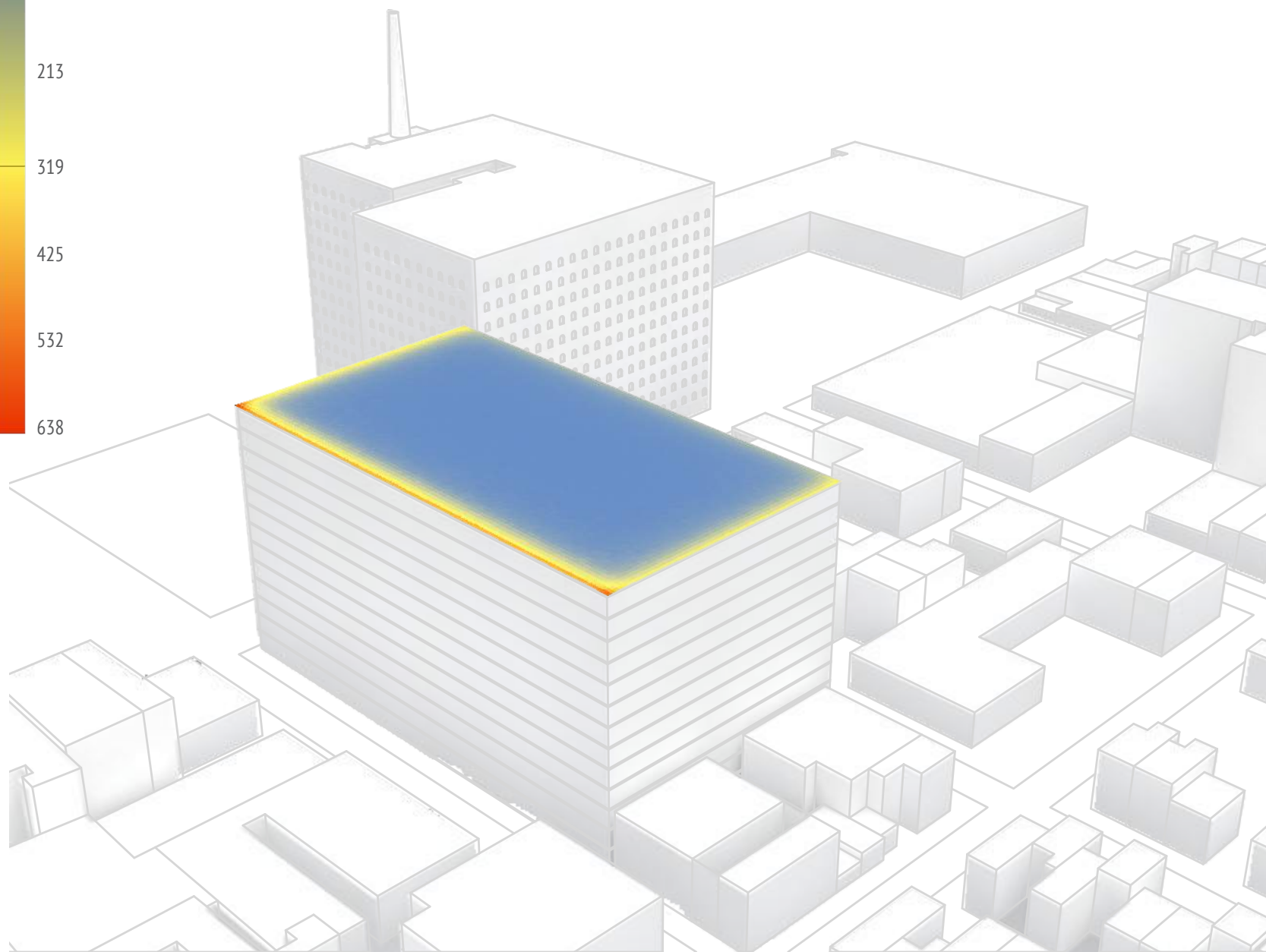
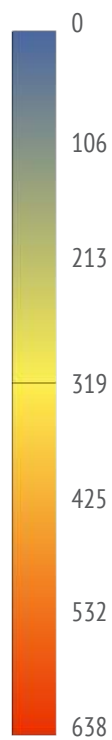
MEAN DAYLIGHT FACTOR : 4.3%

OCCUPANCY : 3650 HOURS PER YEAR

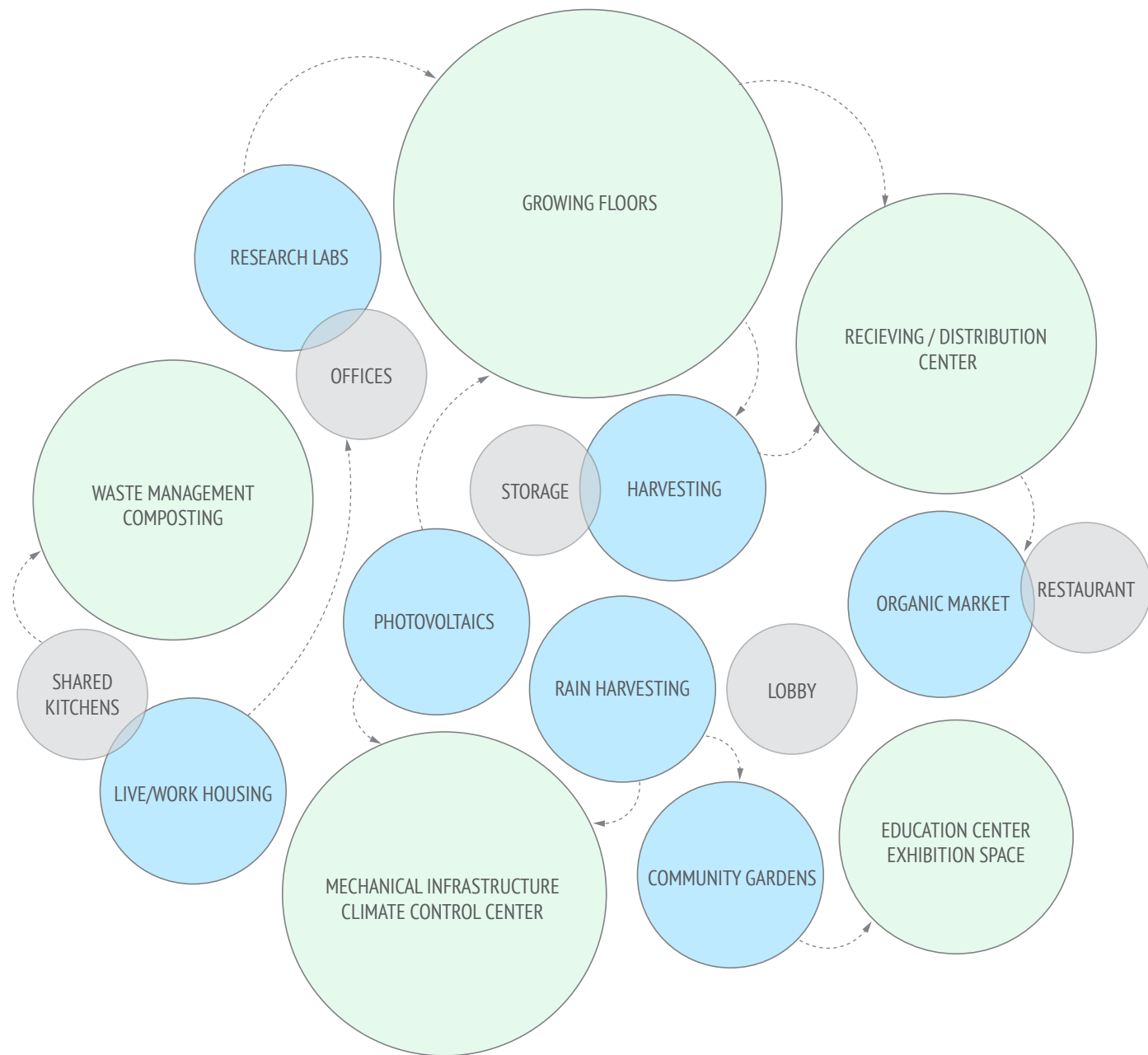


RADIATION ,KWh/m2

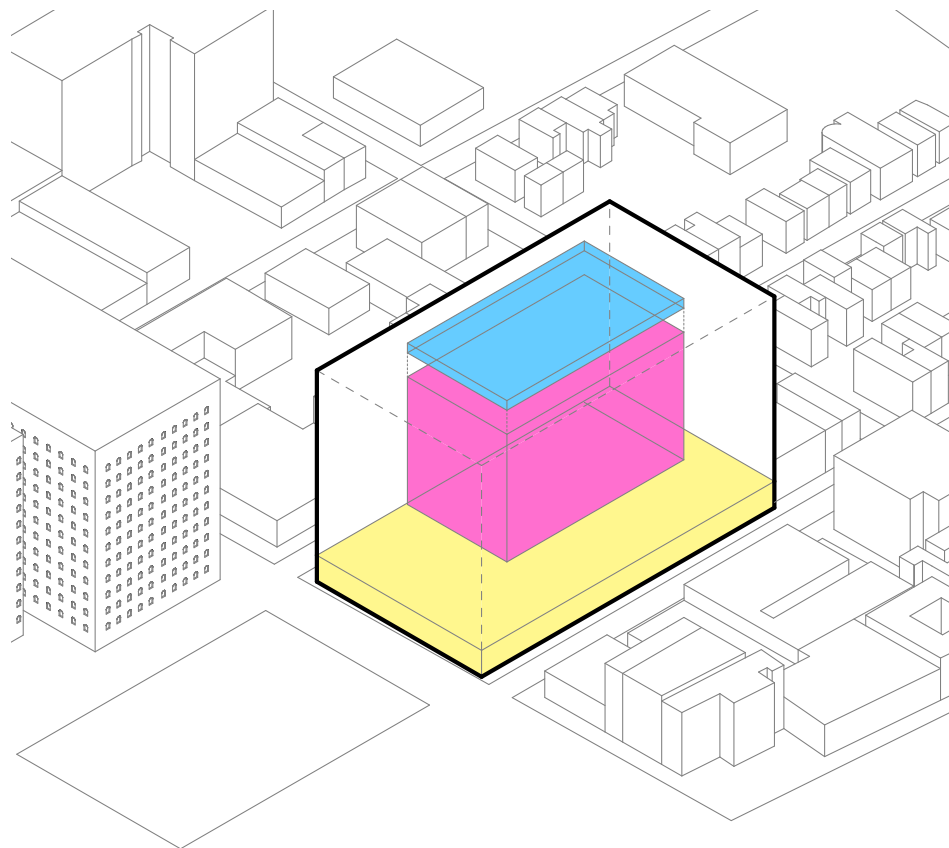
## RADIATION MAP NODES ANALYSIS



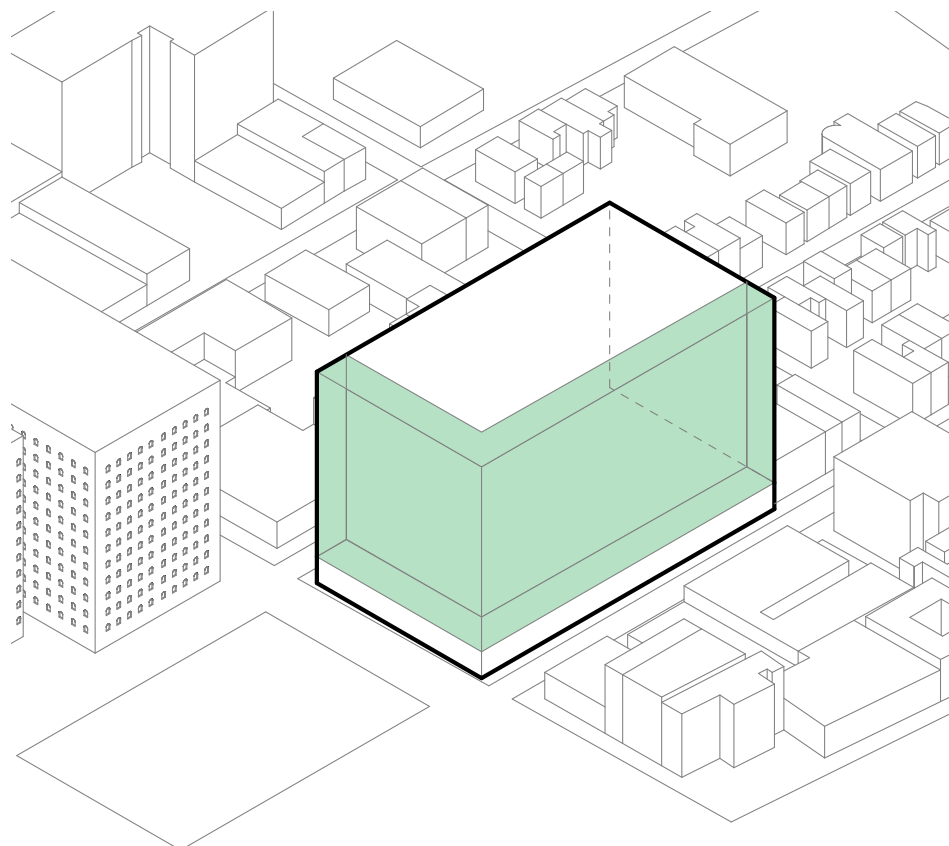




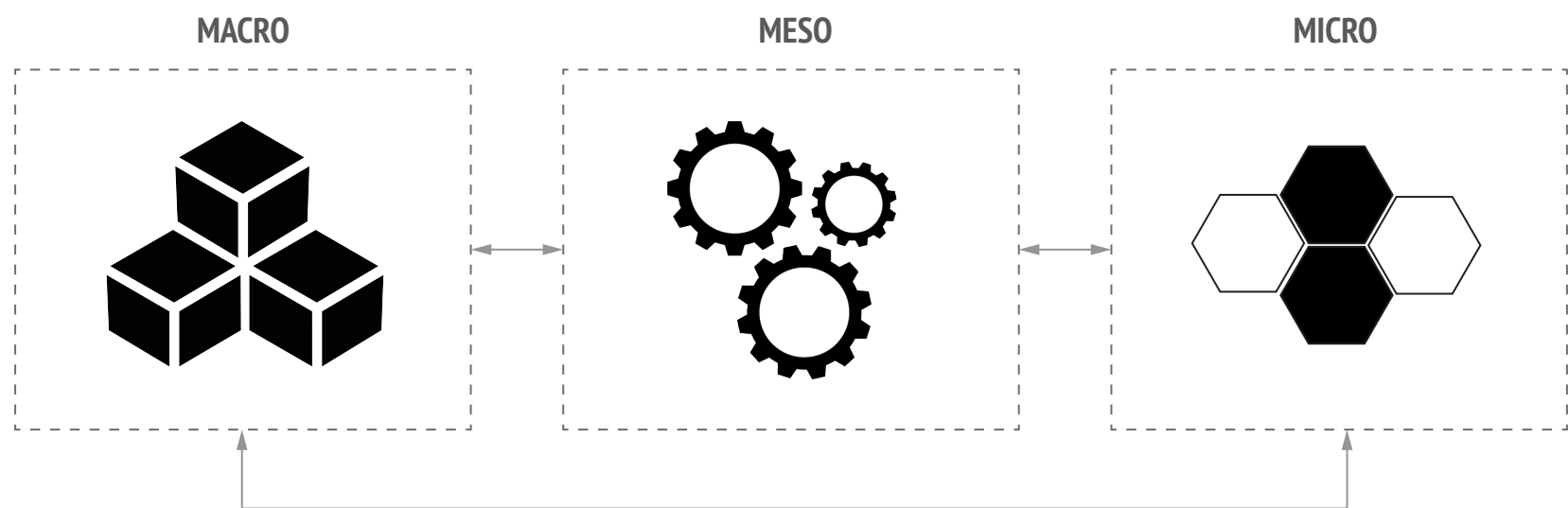
- PHOTOVOLTAICS
- CONTROLLED HYDROPONICS
- FARMERS MARKET | RESTAURANT



- VERTICAL GREENHOUSE



# METHODOLOGY



## **MACRO-SCALE**

Initial building forms are generated based on site conditions and the surrounding urban context. Site location, views, sunlight, shadows, and maximum plant growth potential are taken into account when assessing potential forms.

## **MESO-SCALE**

Within the urban farm programmatic relationships are determined based on the amount of square footage needed. Furthermore, the mechanical and structural systems are assessed for specific parts of the program in order to determine proper locations for each.

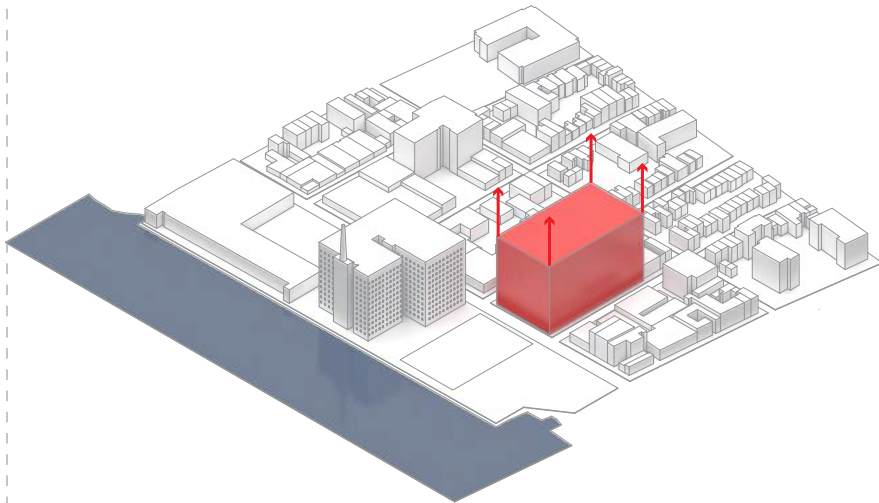
## **MIRCO-SCALE**

This scale focuses on the building envelope and how it responds to program. Concept, performance, and assembly are assessed for each facade type generated. By analyzing the building at this scale an envelope can be selected that has a high ability to modulate light for plant growth.



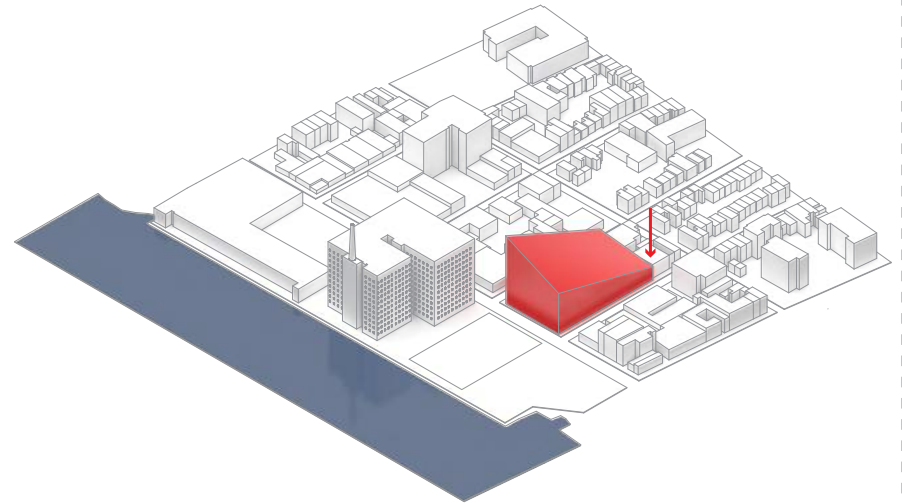
# PARAMETERS

MAXIMUM BUILDING HEIGHT 200'



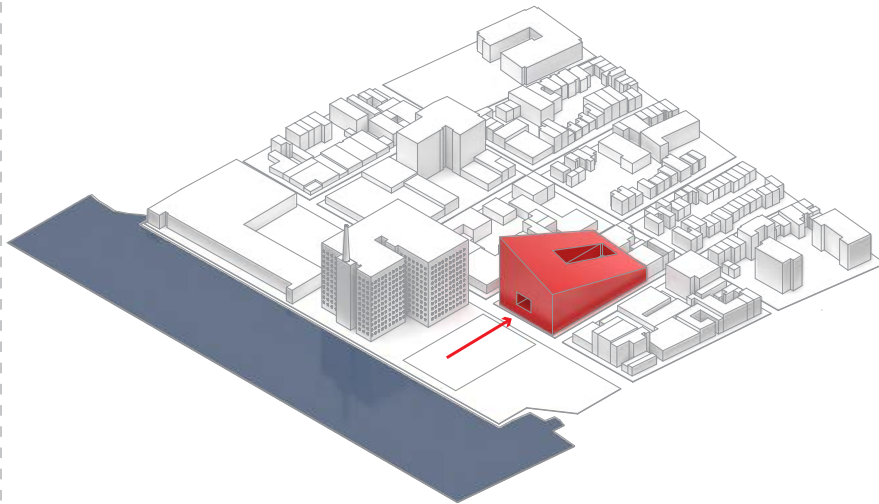
PARAMETER 1

SOUTHEAST CORNER LOWERED TO 40'



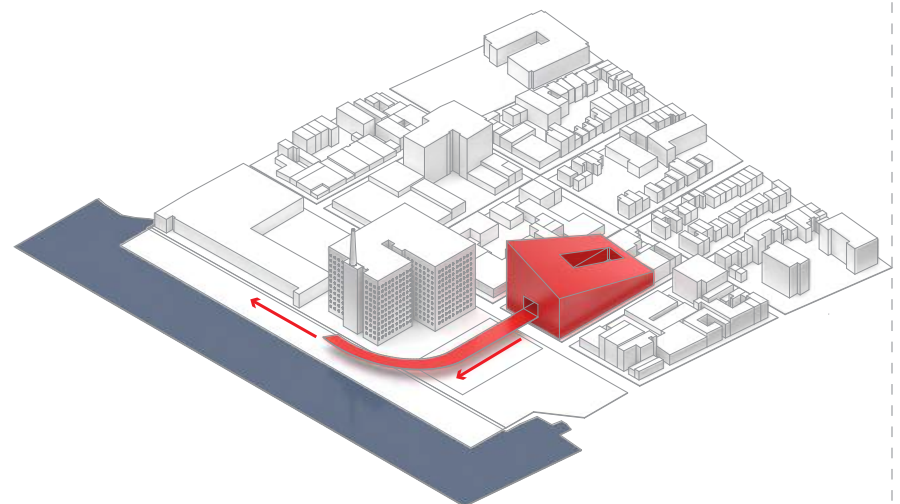
PARAMETER 2

CENTRAL VOID CREATES A PUBLIC COURTYARD



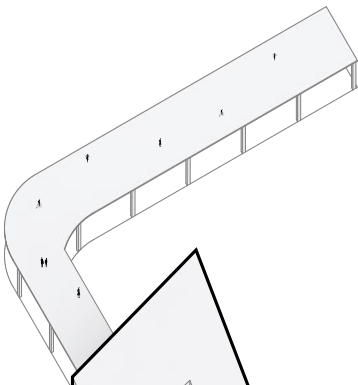
PARAMETER 3

HIGHLINE CONNECTION

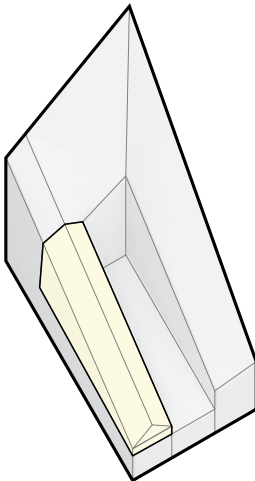
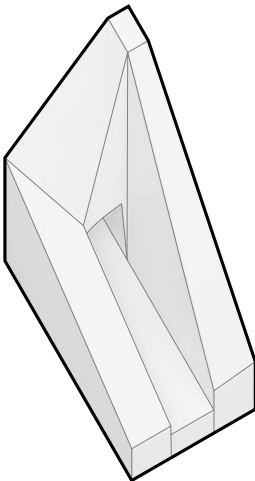


PARAMETER 4

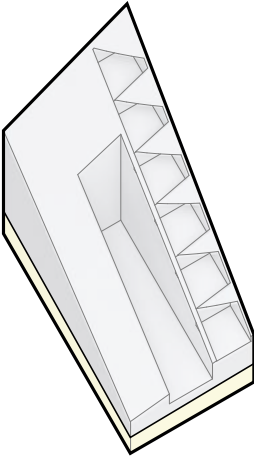
# PROGRAM CONSIDERATIONS



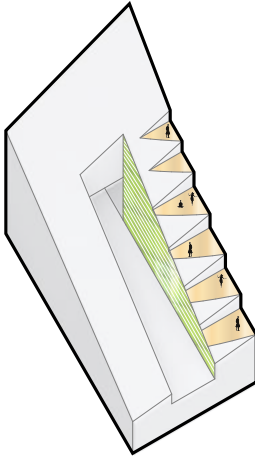
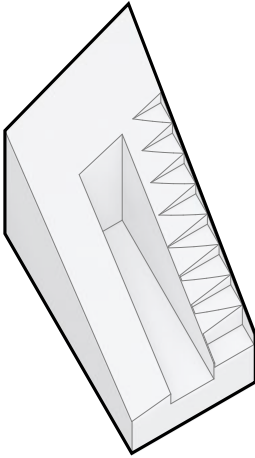
A COURTYARD WILL BE LOCATED IN THE CENTER OF THE BUILDING WHICH WILL HOST VARIOUS ACTIVITIES SUCH AS TRADITIONAL FARMING AND COMMUNITY ENGAGEMENT PROGRAMS.



A 35,000 SQUARE FOOT GREENHOUSE WILL RUN ALONG THE SOUTHERN FACADE.

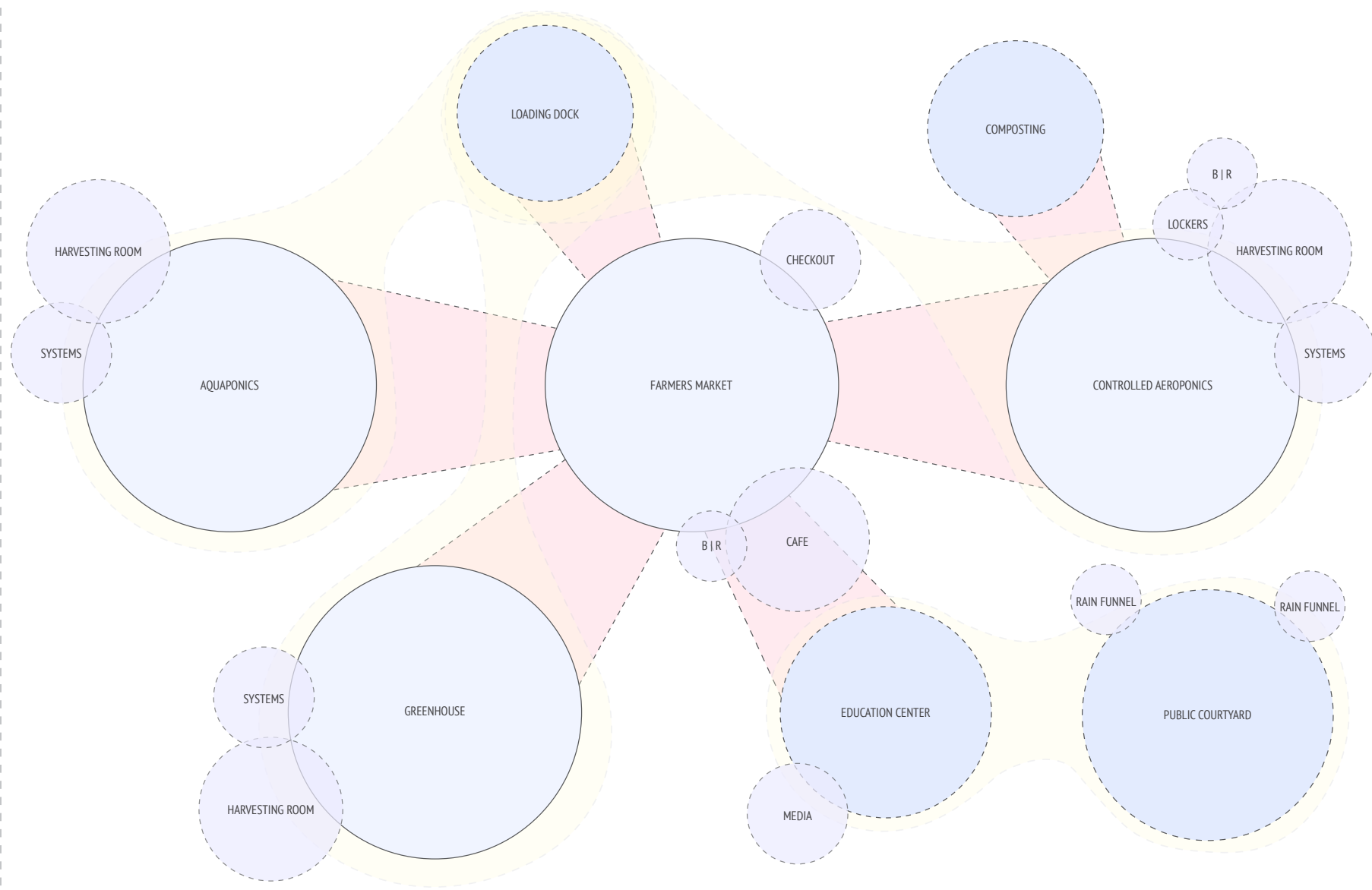


THE GROUND FLOOR PROGRAM WILL CONTAIN A FARMERS MARKET, COMMUNITY EDUCATION CENTER, VIEWING ROOM FOR CONTROLLED HYDROPONICS, AND A VIRTUAL INTERACTIVE MEDIA ROOM.



A SERIES OF STEPPED TERRACES PROVIDES ACTIVE OUTDOOR SPACE FOR RESEARCH LABS AND EMPLOYEE HOUSING.

# PROGRAMATIC RELATIONSHIPS







GREENHOUSE, AQUAPONICS,  
AND HYDROPONICS SERVICES

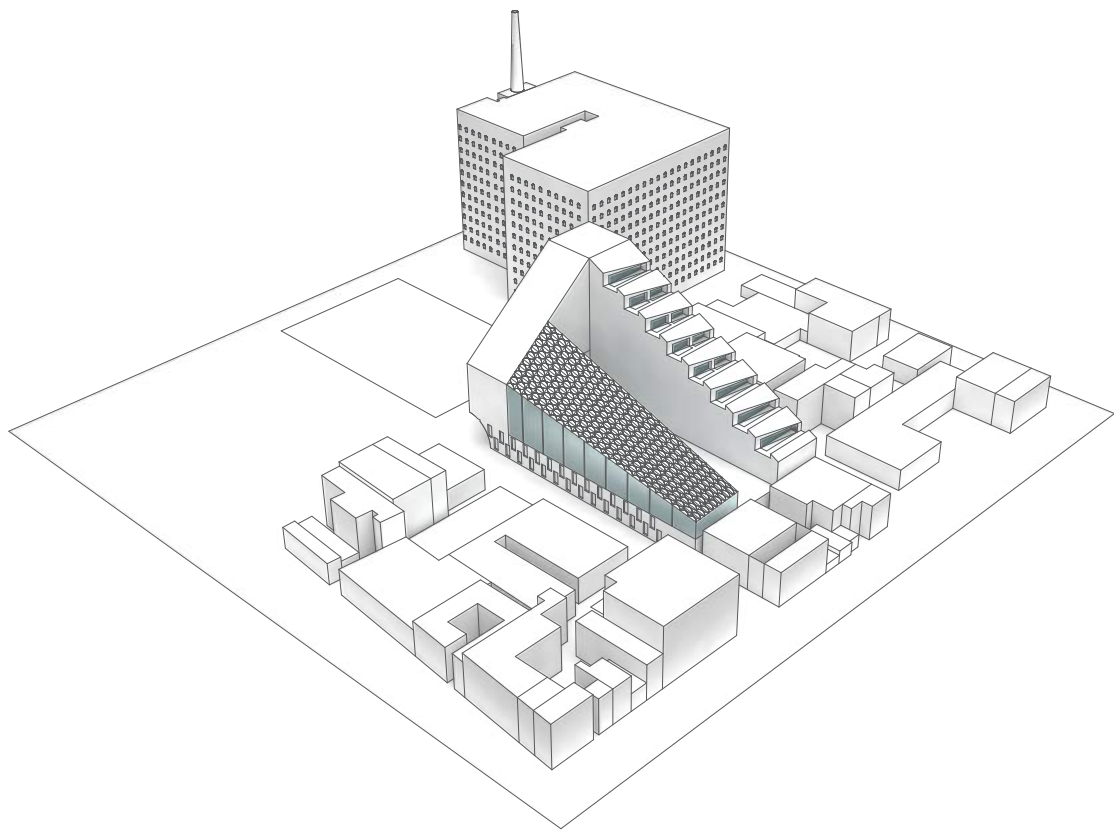


GREENHOUSE AND VERTICAL  
GROW WALL SERVICES

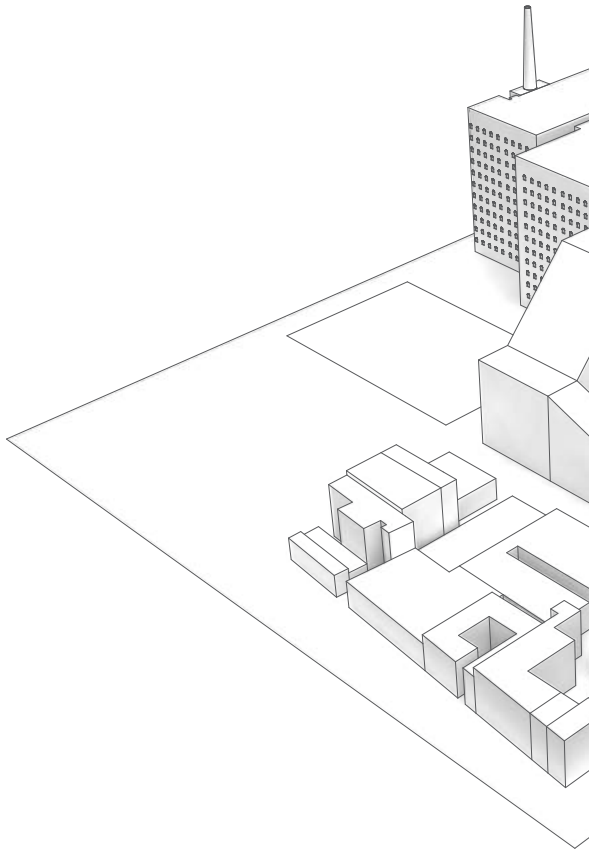




ITERATION

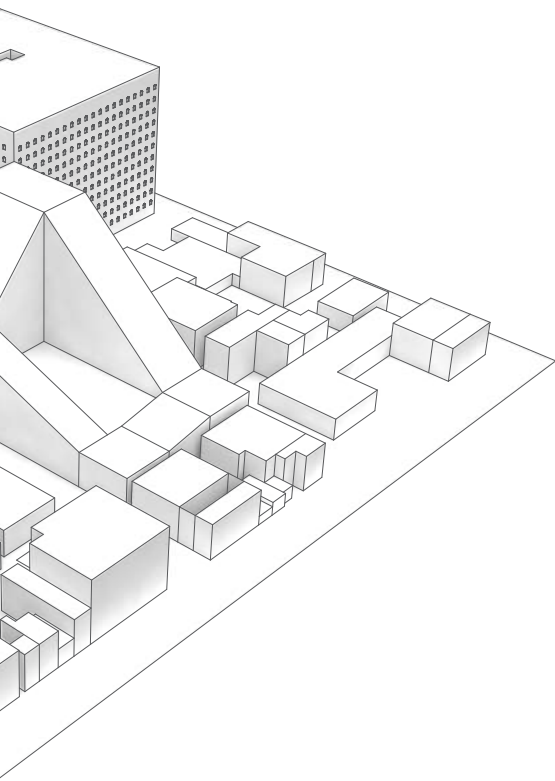


ITERATION 1

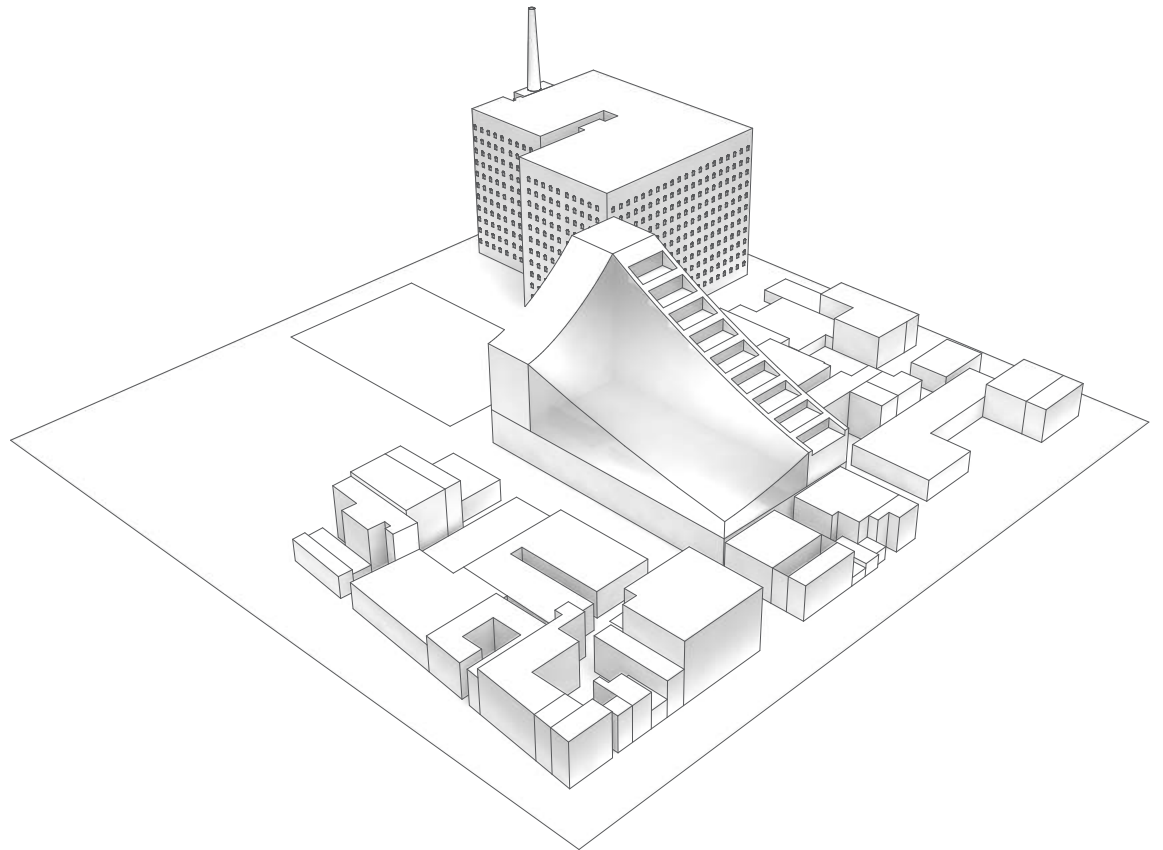


ITERATION

# SELECTION

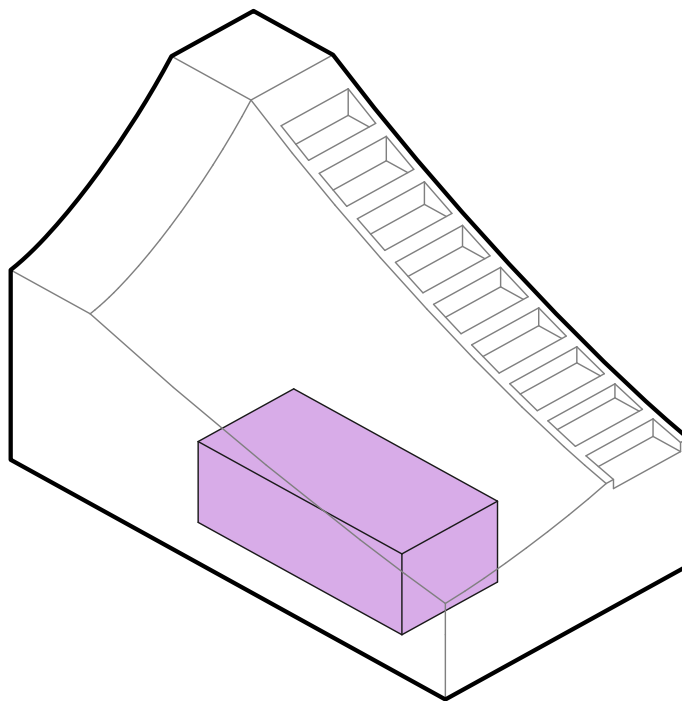


ON 2

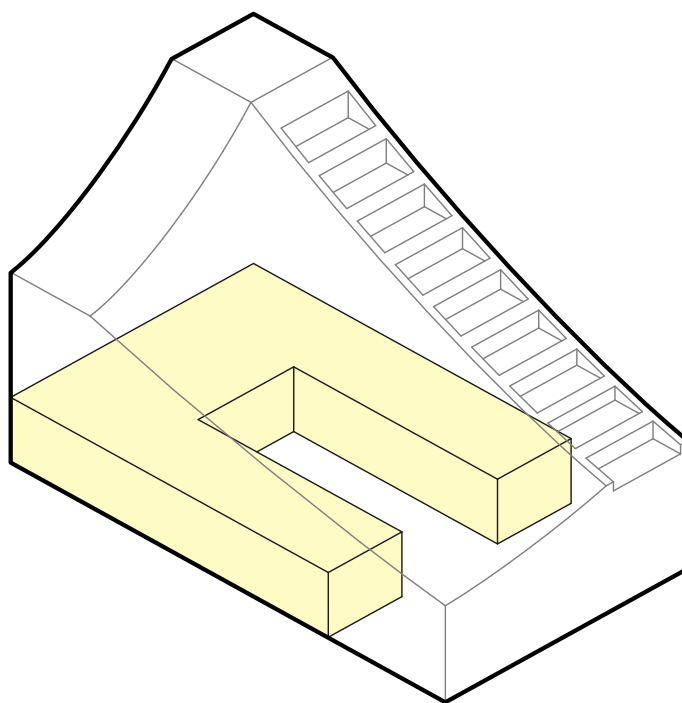
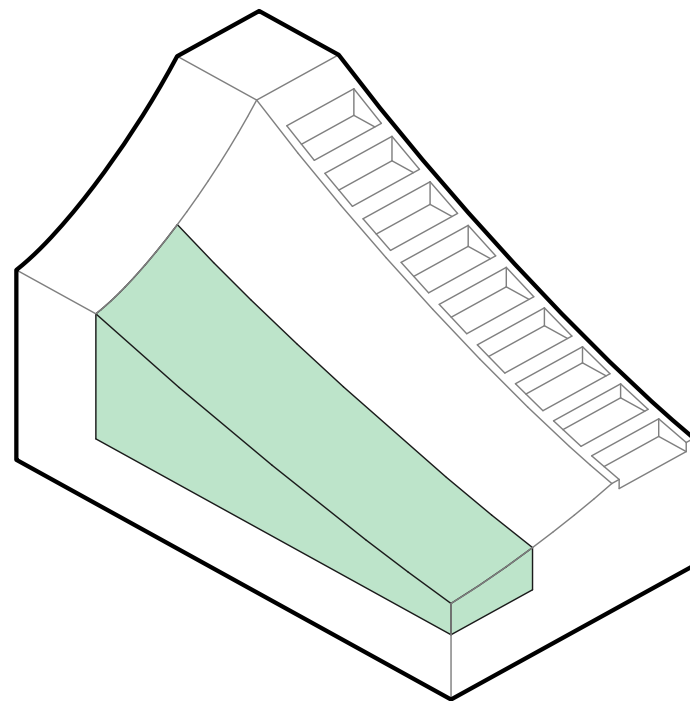


ITERATION 3

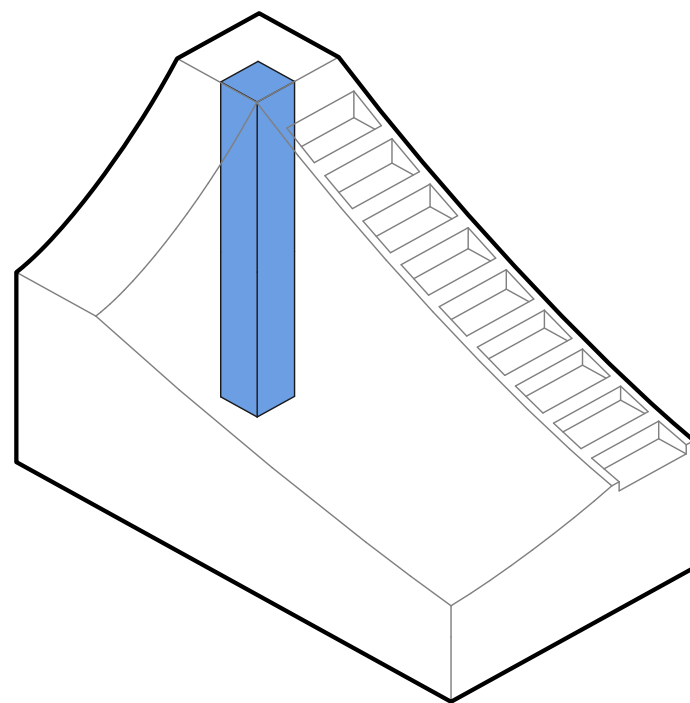
CONTROLLED AEROPONICS



GREENHOUSE HYDROPONICS

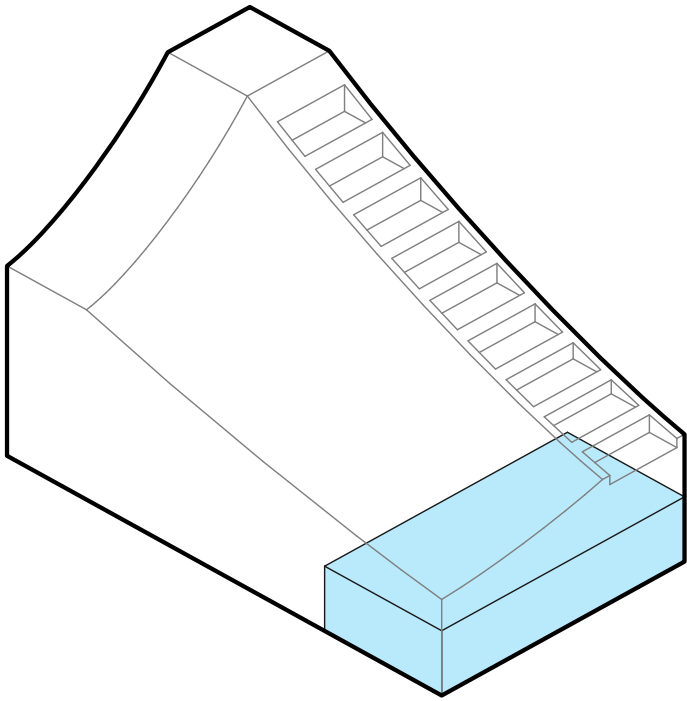


FARMER'S MARKET | RESTAURANT | LOBBY

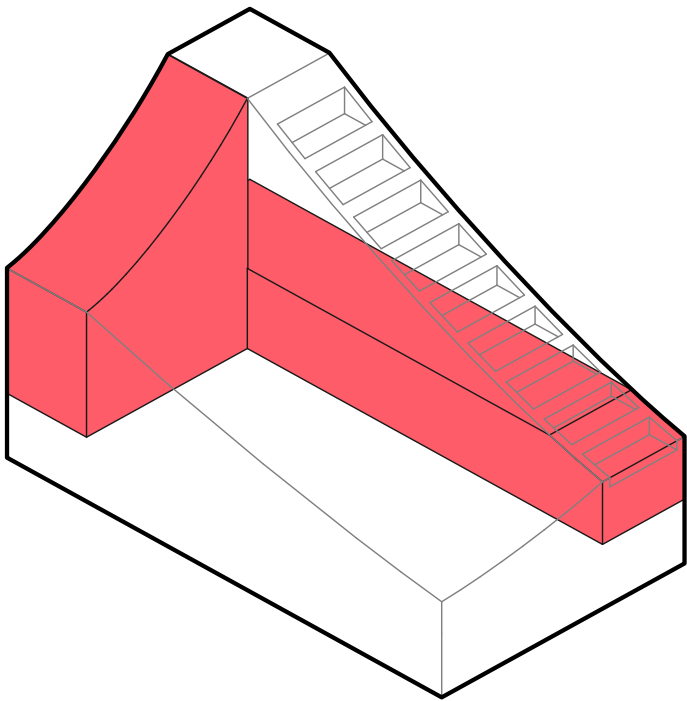
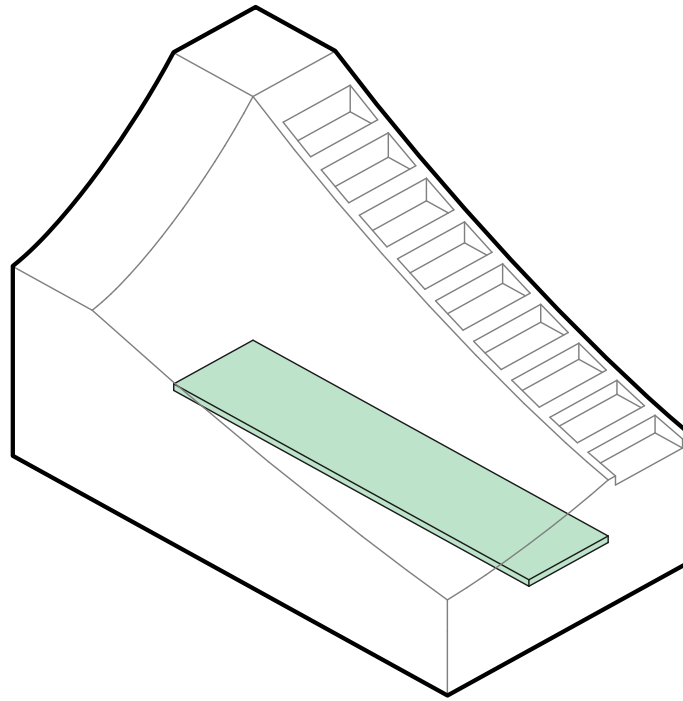


CORE (PASSENGER ELEVATOR + FREIGHT)

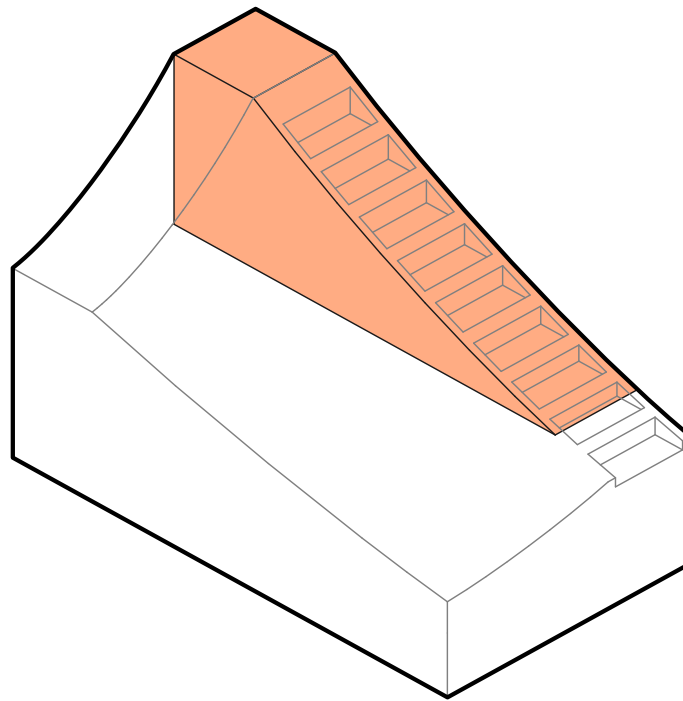
SYSTEMS | CONTROL ROOM



PUBLIC COURTYARD



OFFICES | RESEARCH LABS | COMMUNITY GROW CENTER

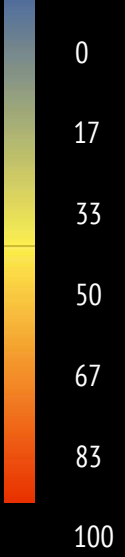


ADDITIONAL RESEARCH SPACE + TERRACES



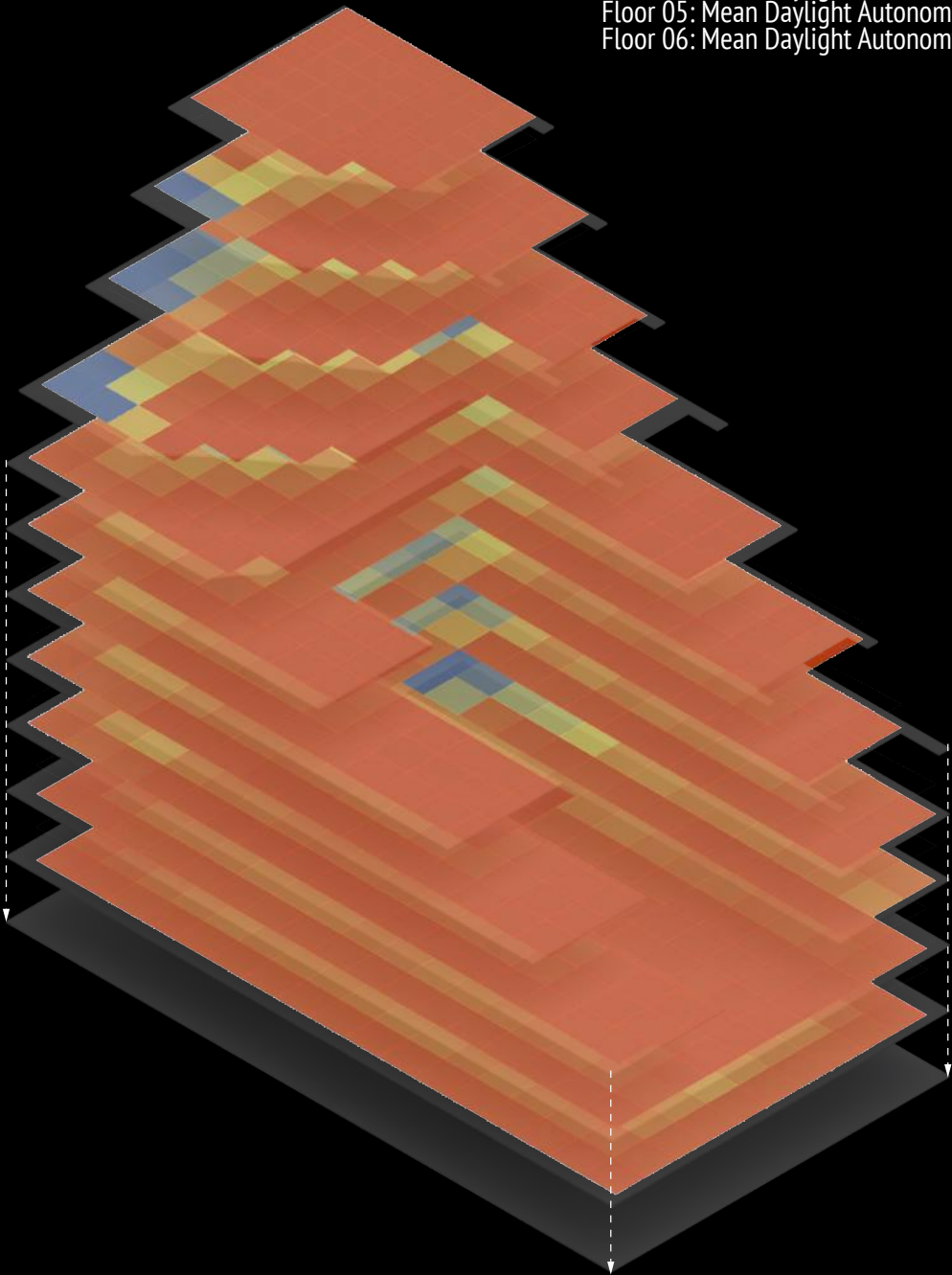
# Lux Level Suitable Fo

% Occupied  
Hours



Daylight Autonomy  
Simulation

Floor 00: Mean Daylight Autonomy = 51.01 %  
Floor 01: Mean Daylight Autonomy = 85.32 %  
Floor 02: Mean Daylight Autonomy = 95.00 %  
Floor 03: Mean Daylight Autonomy = 67.51 %  
Floor 04: Mean Daylight Autonomy = 83.92 %  
Floor 05: Mean Daylight Autonomy = 69.38 %  
Floor 06: Mean Daylight Autonomy = 70.23 %

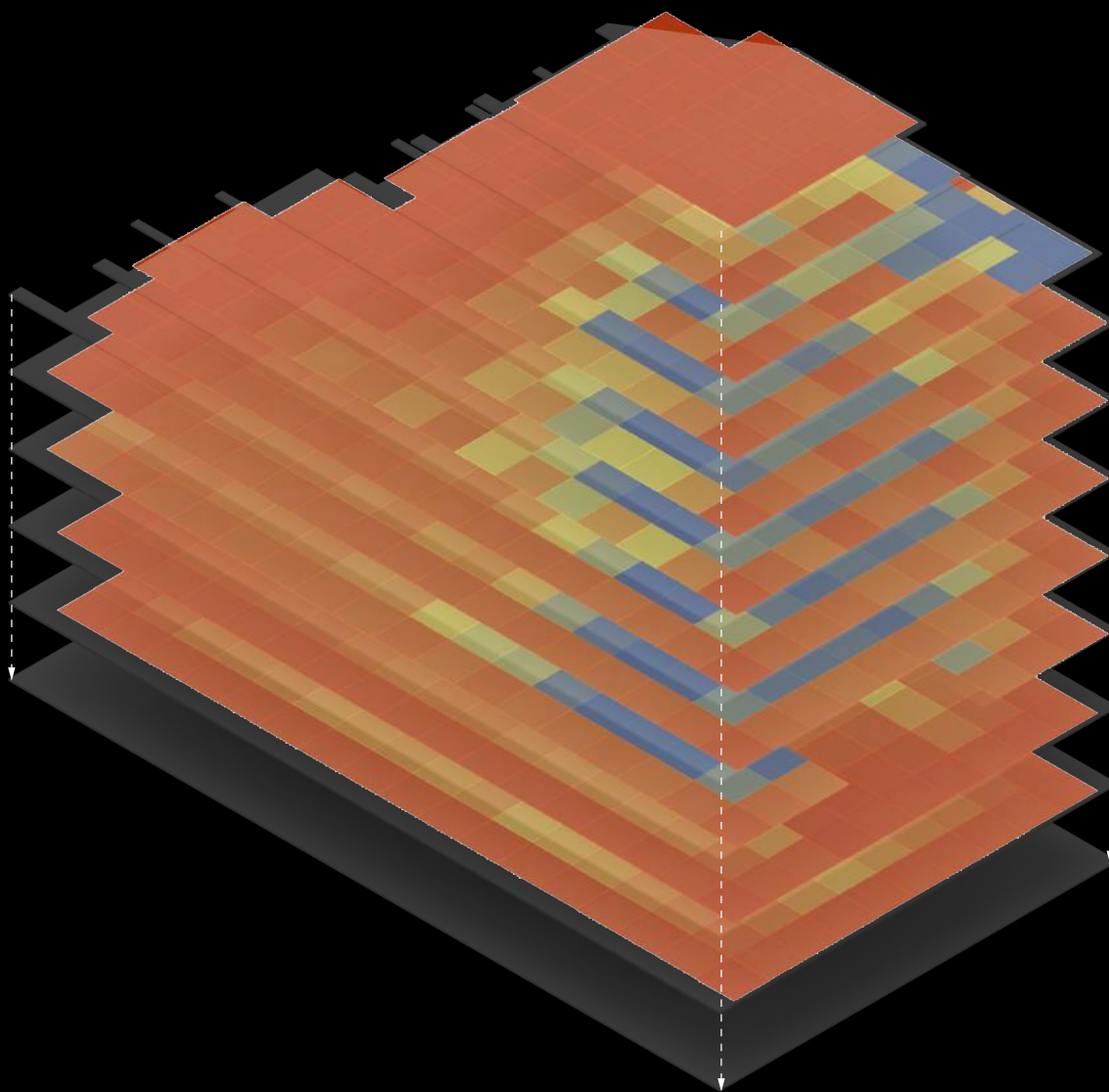


Southeast Orientation

# r Office / Work Space

onomy (300 LUX)  
tion

Floor 07: Mean Daylight Autonomy = 67.27 %  
Floor 08: Mean Daylight Autonomy = 68.94 %  
Floor 09: Mean Daylight Autonomy = 66.88 %  
Floor 10: Mean Daylight Autonomy = 69.01 %  
Floor 11: Mean Daylight Autonomy = 38.74 %  
Floor 12: Mean Daylight Autonomy = 80.62 %  
Floor 13: Mean Daylight Autonomy = 95.42 %

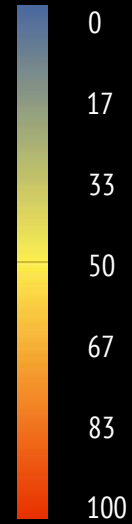


Northwest Orientation

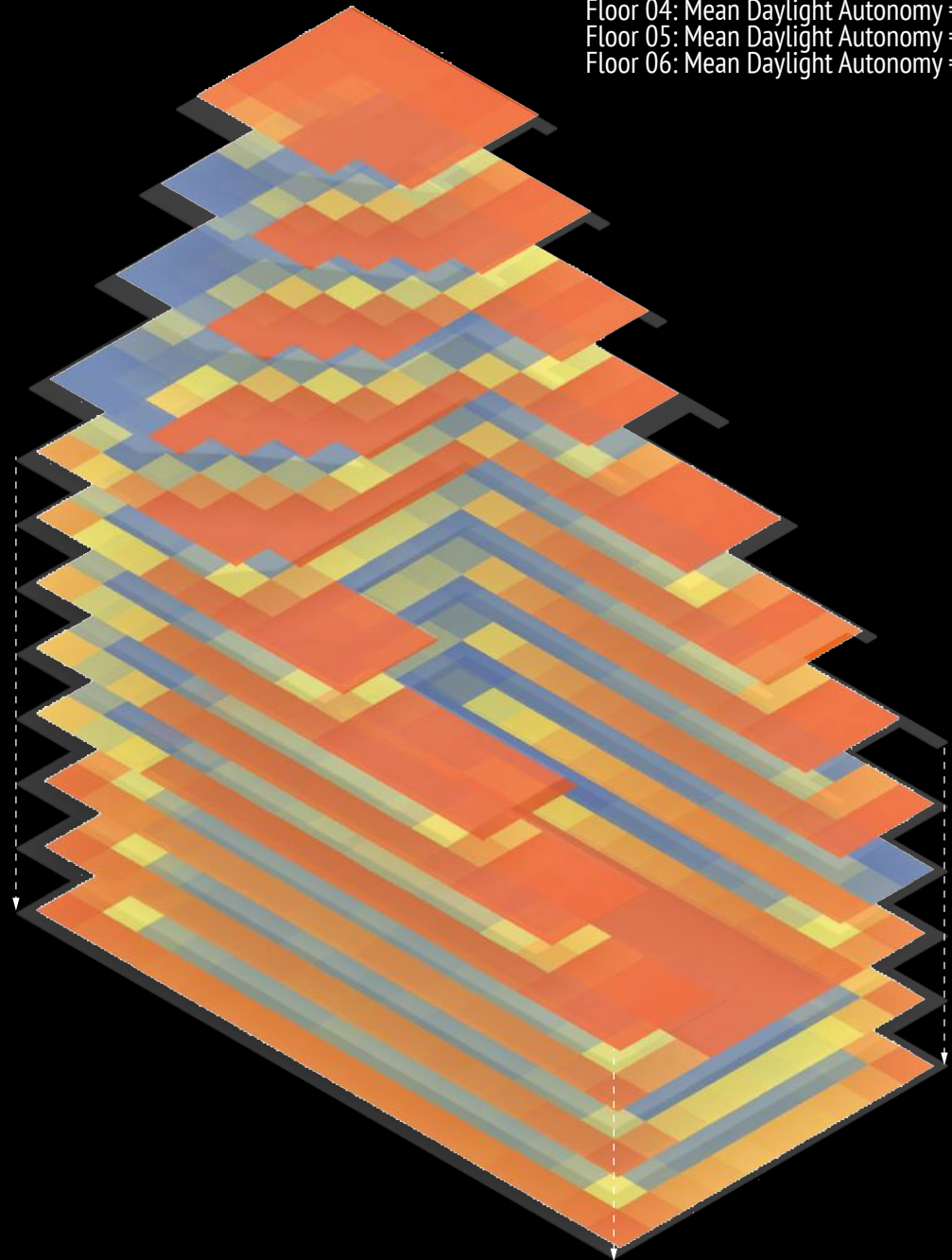
# Lux Level Suitability

Daylight Autonomy  
Simulation

% Occupied  
Hours



Floor 00: Mean Daylight Autonomy = 24.28 %  
Floor 01: Mean Daylight Autonomy = 20.99 %  
Floor 02: Mean Daylight Autonomy = 41.19 %  
Floor 03: Mean Daylight Autonomy = 91.59 %  
Floor 04: Mean Daylight Autonomy = 19.35 %  
Floor 05: Mean Daylight Autonomy = 47.22 %  
Floor 06: Mean Daylight Autonomy = 32.01 %



Southeast Orientation

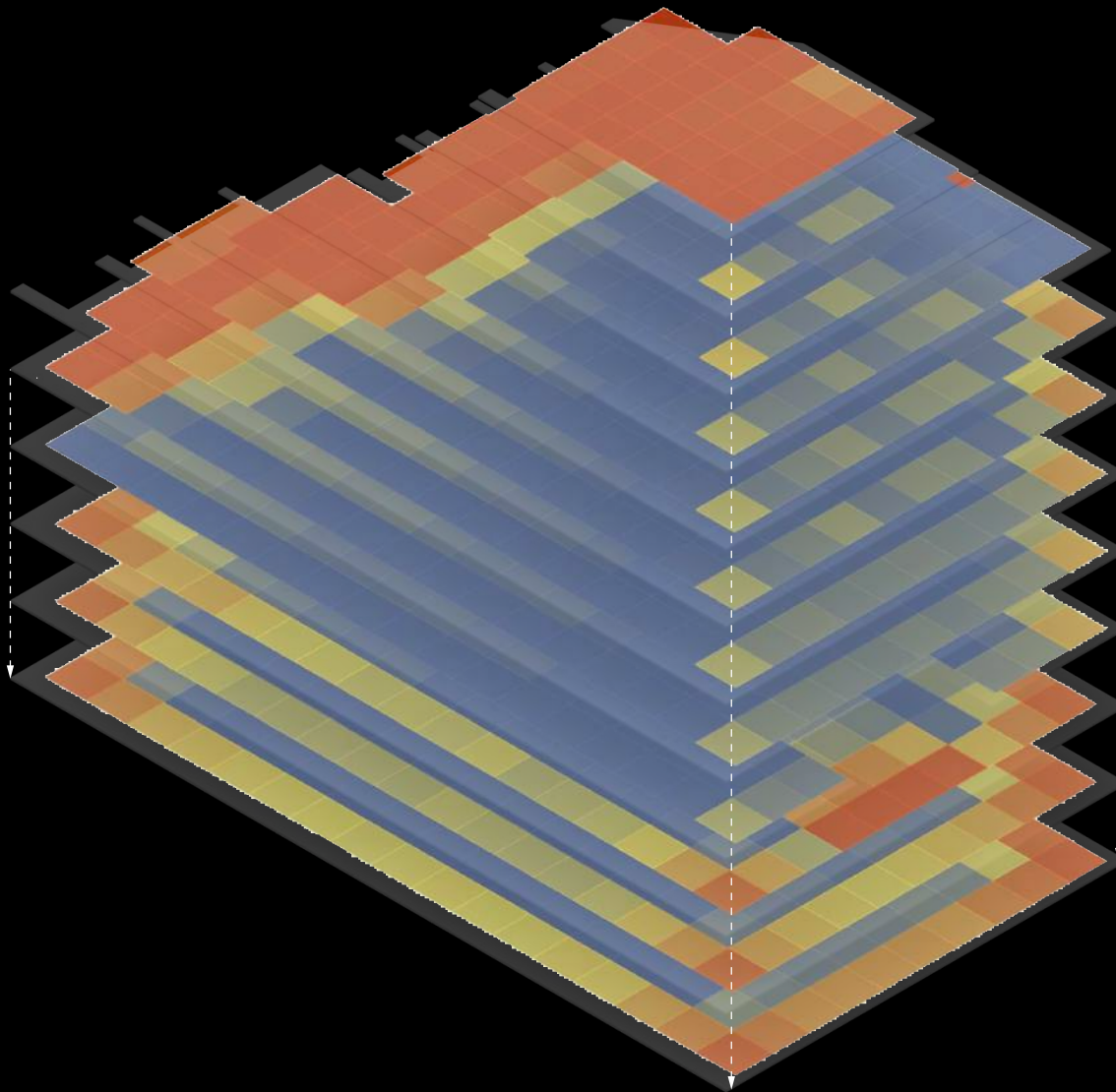


# able For Growing

onomy (1000 LUX)

lation

Floor 07: Mean Daylight Autonomy = 37.13 %  
Floor 08: Mean Daylight Autonomy = 35.58 %  
Floor 09: Mean Daylight Autonomy = 39.53 %  
Floor 10: Mean Daylight Autonomy = 35.51 %  
Floor 11: Mean Daylight Autonomy = 38.74 %  
Floor 12: Mean Daylight Autonomy = 46.26 %  
Floor 13: Mean Daylight Autonomy = 92.22 %



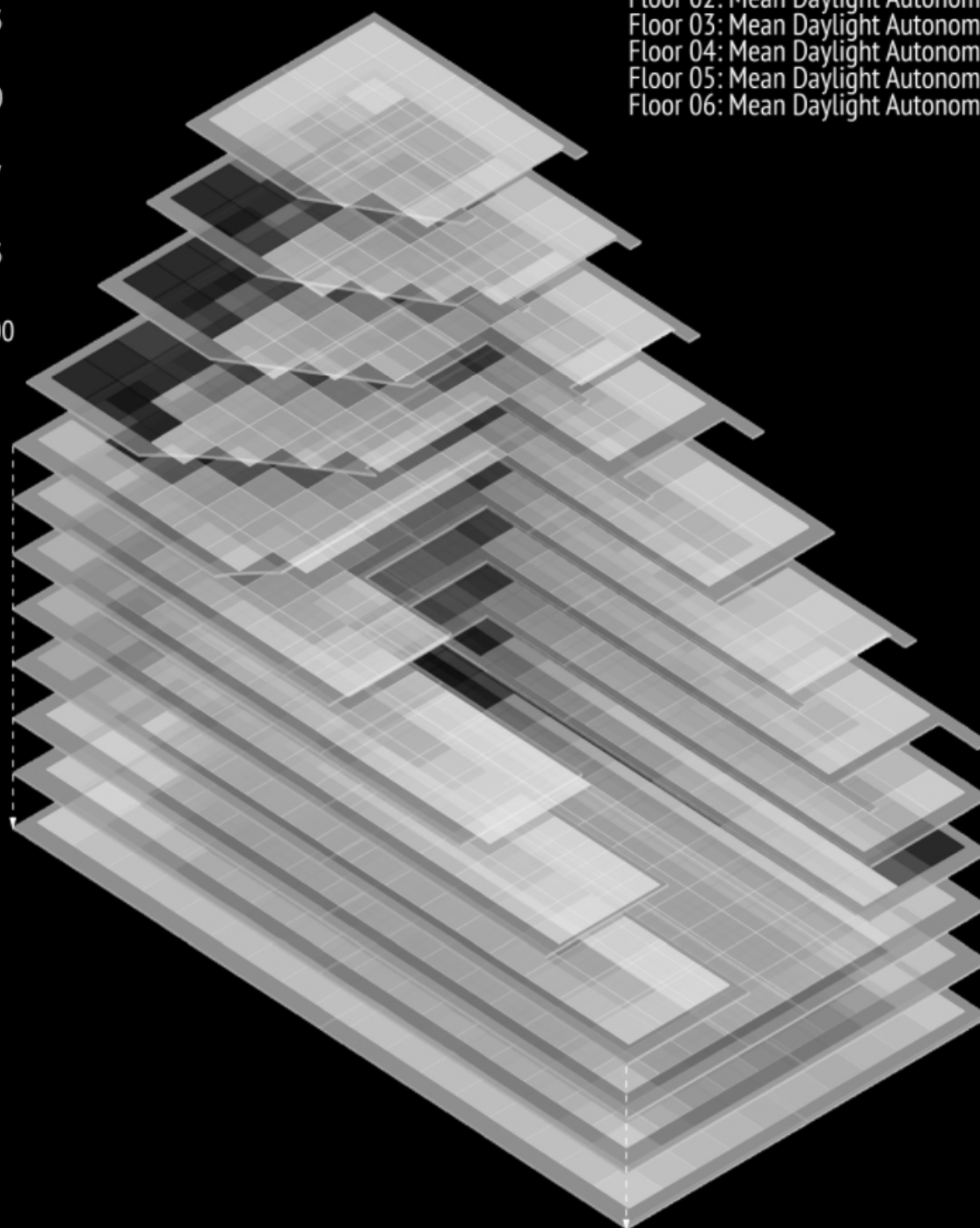
Northwest Orientation



% Occupied  
Hours



Floor 00: Mean Daylight Autonomy = 24.28 %  
 Floor 01: Mean Daylight Autonomy = 20.99 %  
 Floor 02: Mean Daylight Autonomy = 41.19 %  
 Floor 03: Mean Daylight Autonomy = 91.59 %  
 Floor 04: Mean Daylight Autonomy = 19.35 %  
 Floor 05: Mean Daylight Autonomy = 47.22 %  
 Floor 06: Mean Daylight Autonomy = 32.01 %



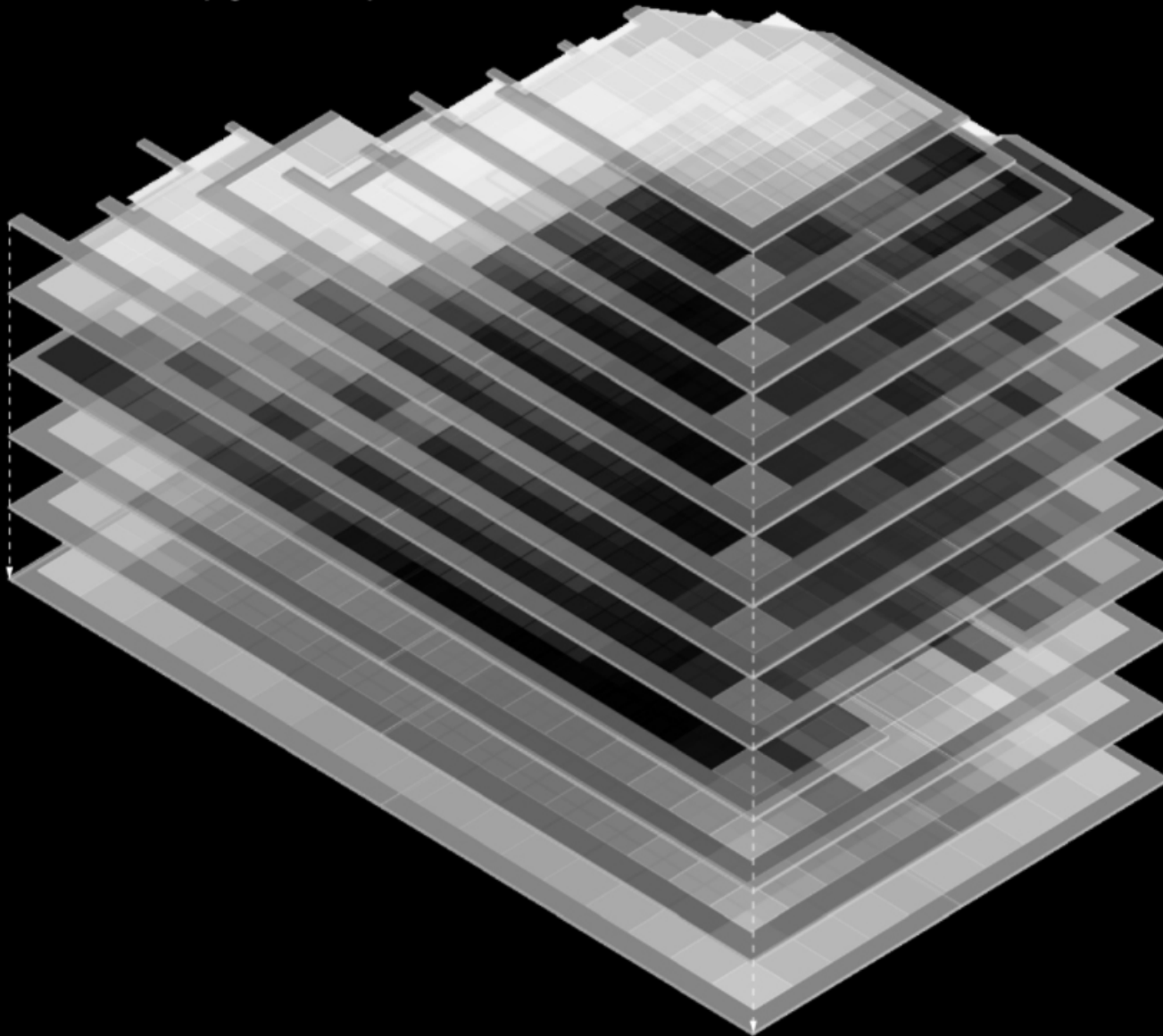
Southeast Orientation

# DAYLIGHT AUTONOMY

DAYLIGHT IS AVAILABLE

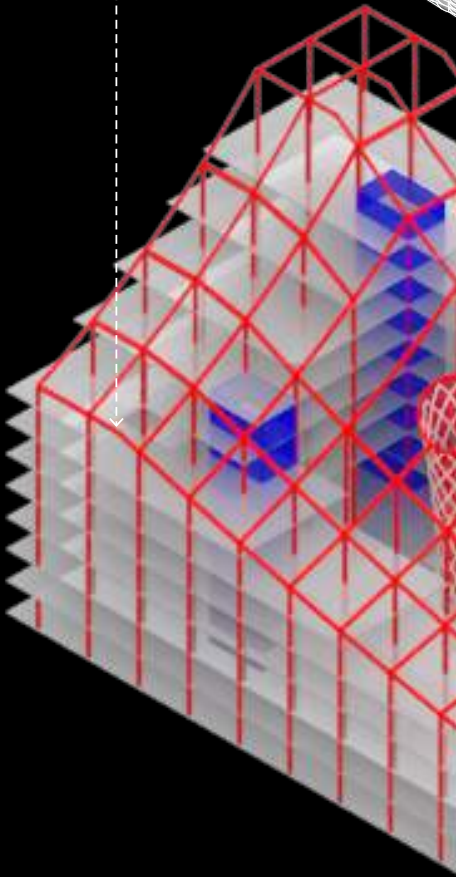
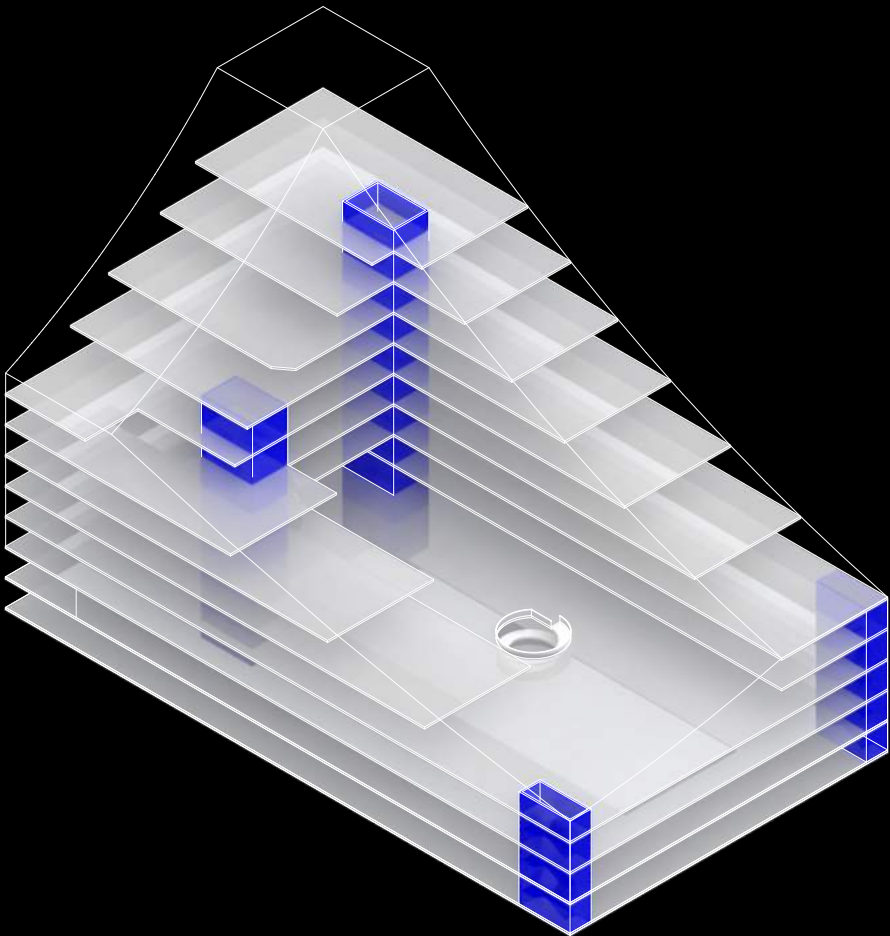
Simulation

Floor 07: Mean Daylight Autonomy = 37.13 %  
Floor 08: Mean Daylight Autonomy = 35.58 %  
Floor 09: Mean Daylight Autonomy = 39.53 %  
Floor 10: Mean Daylight Autonomy = 35.51 %  
Floor 11: Mean Daylight Autonomy = 38.74 %  
Floor 12: Mean Daylight Autonomy = 46.26 %  
Floor 13: Mean Daylight Autonomy = 92.22 %

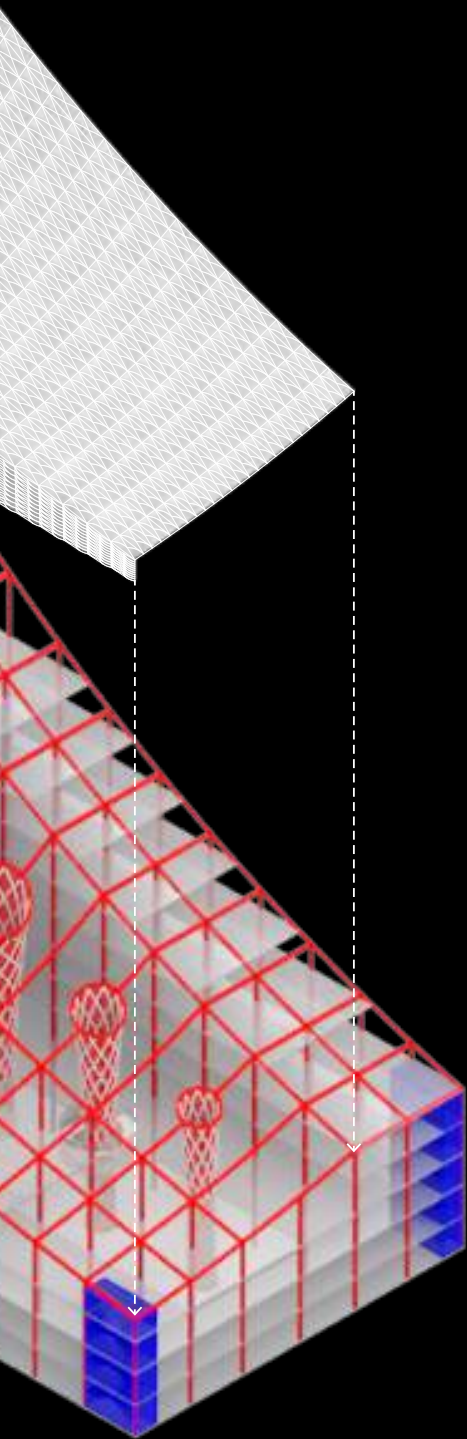


Northwest Orientation

BUILDING CORES + FLOOR PLATES

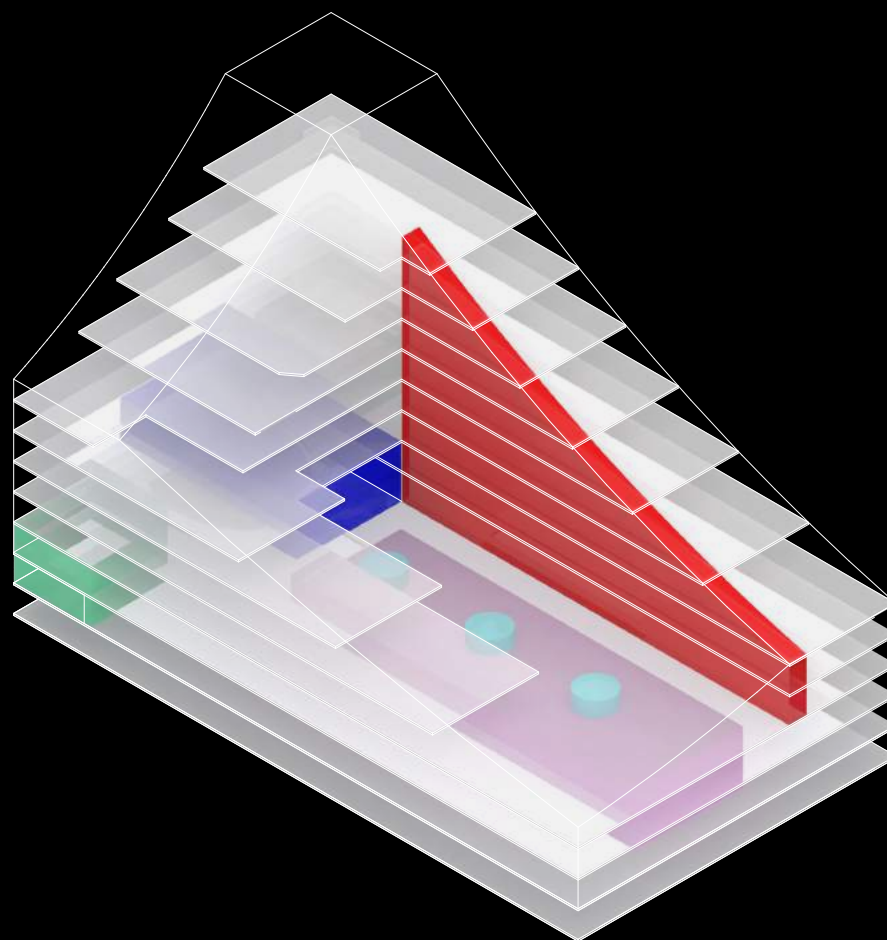


COLUMNS + BEAMS



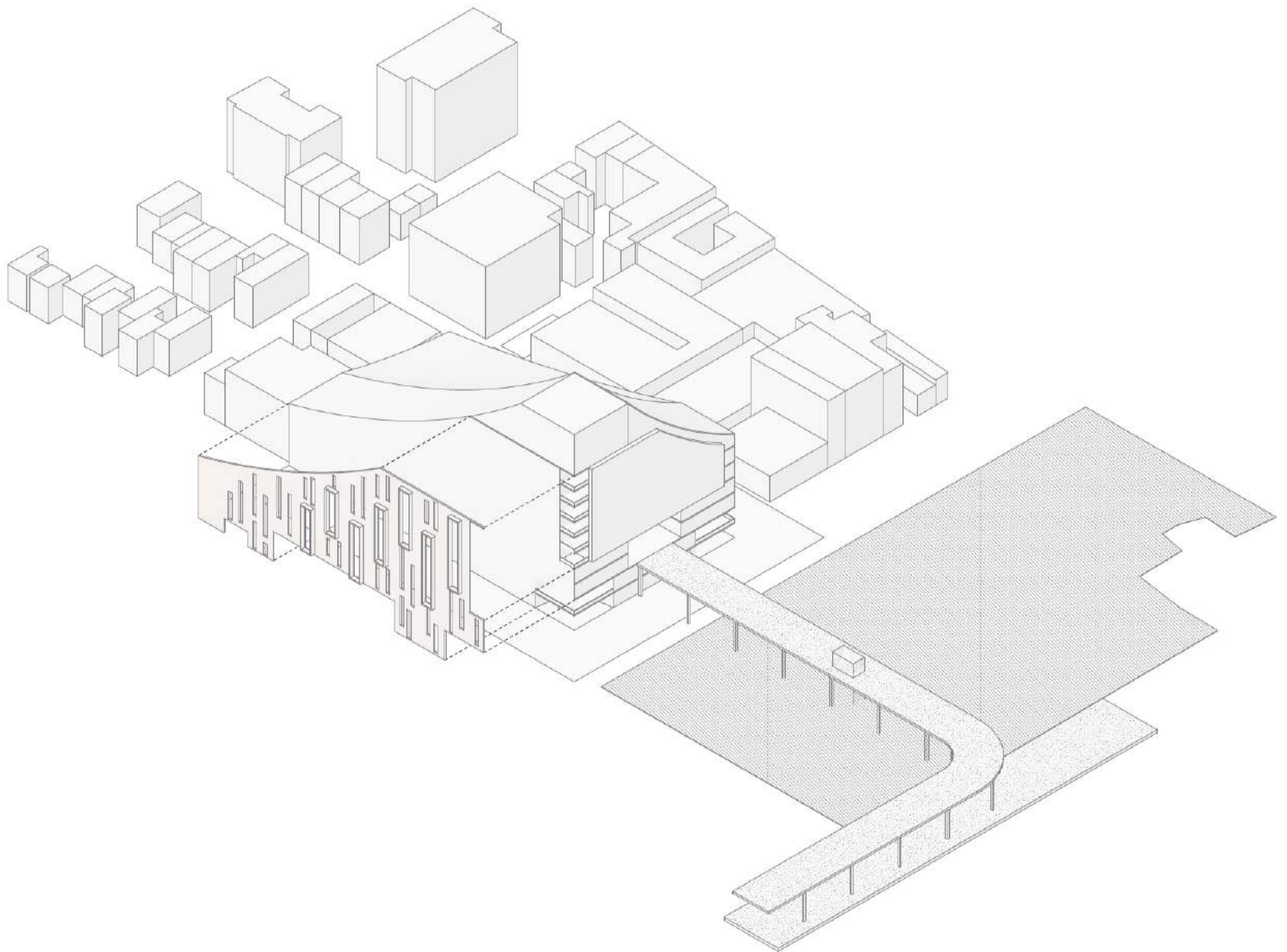
MS + ETFE MEMBRANE

## PROGRAMATIC STRUCTURAL ISSUES

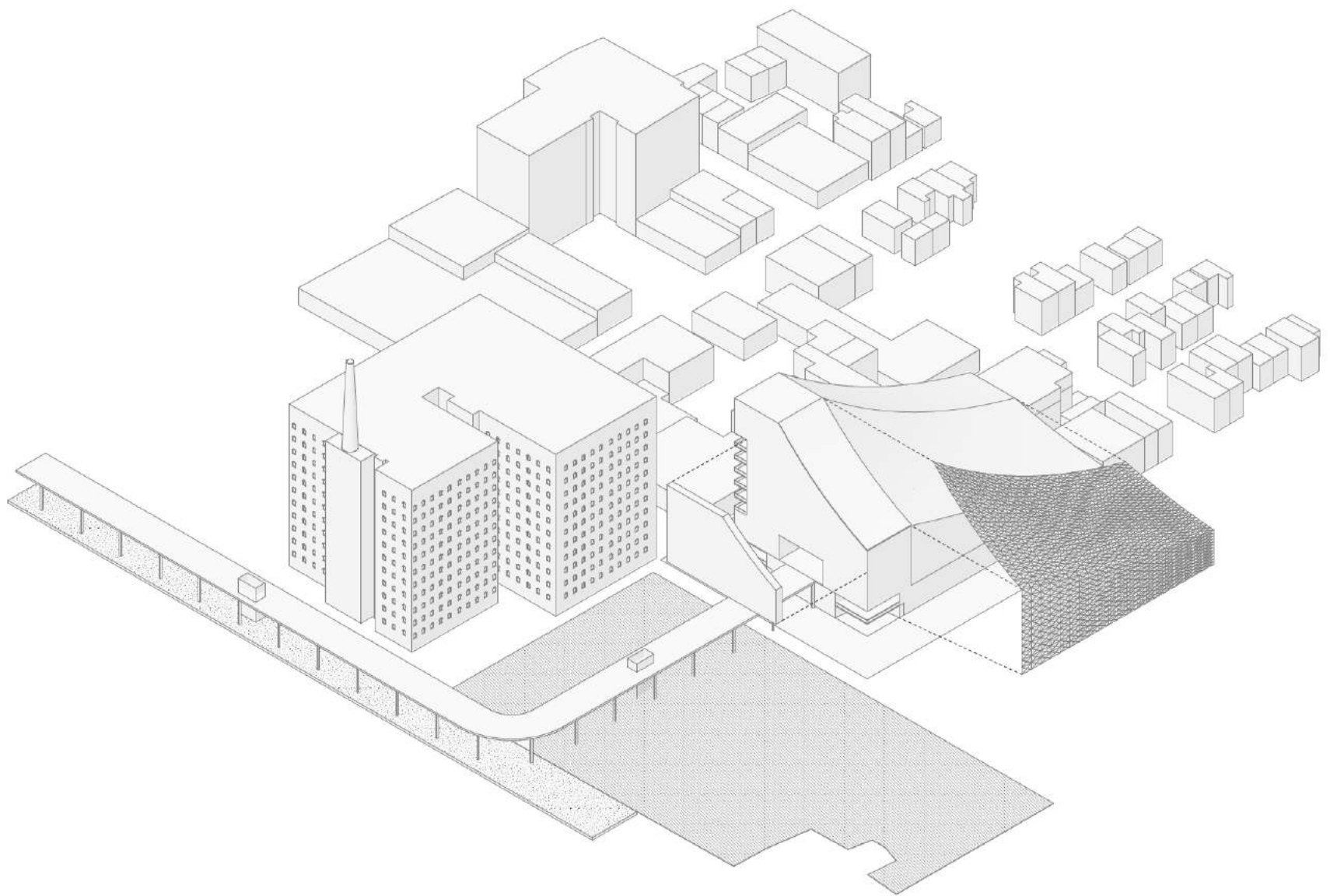




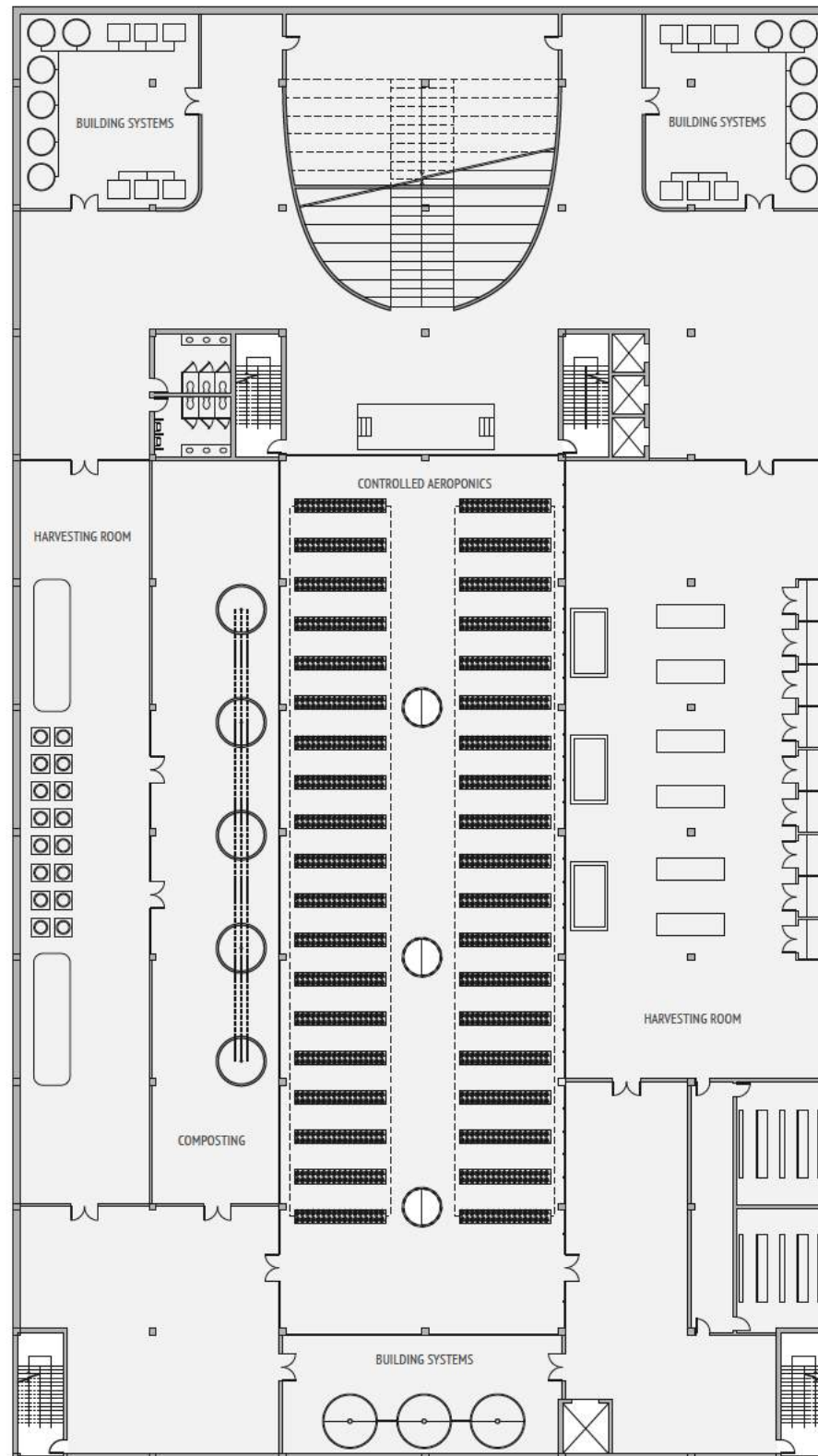
## NORTH FACADE EXPLODED



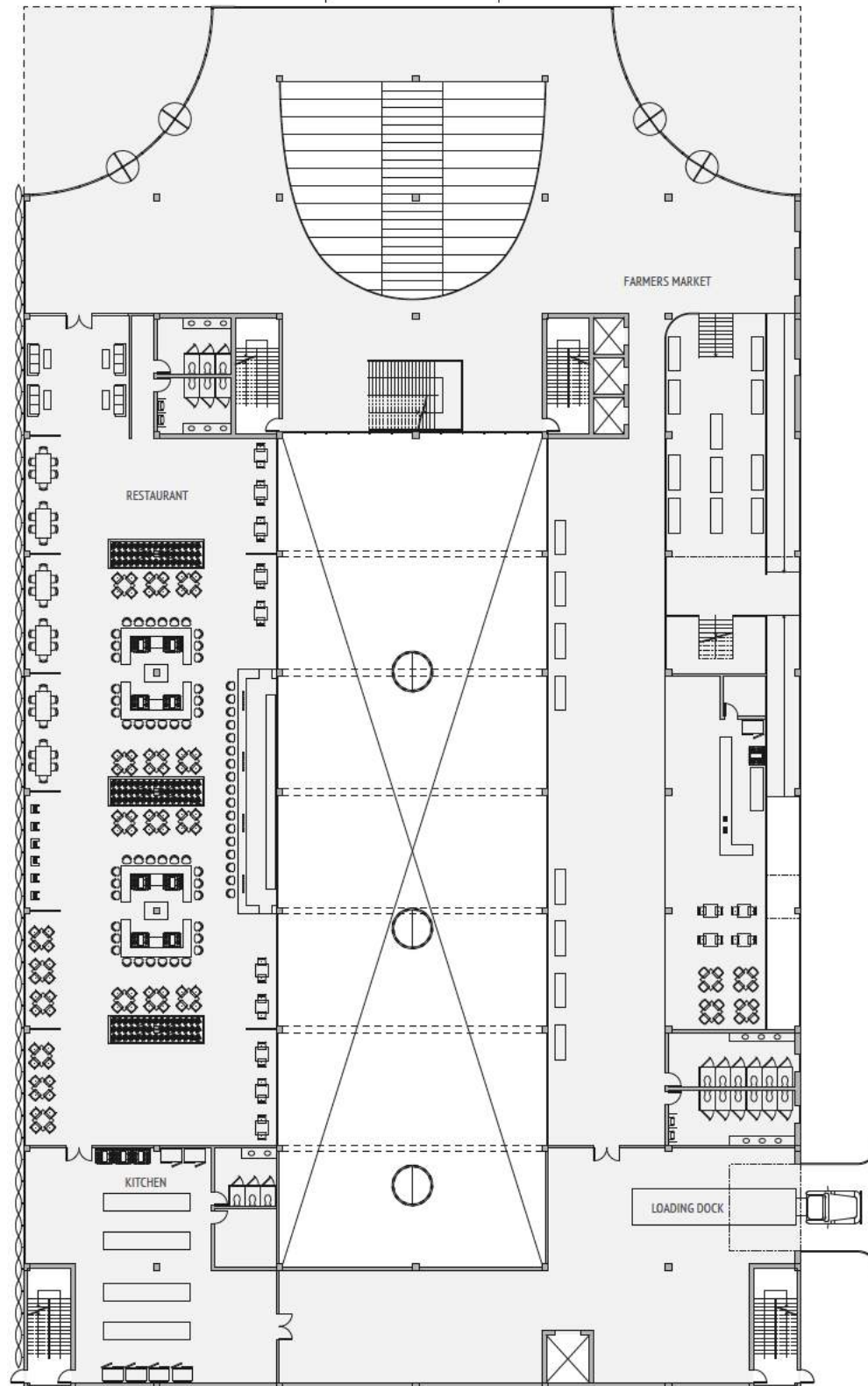
## SOUTH FACADE EXPLODED



## BASEMENT FLOOR PLAN

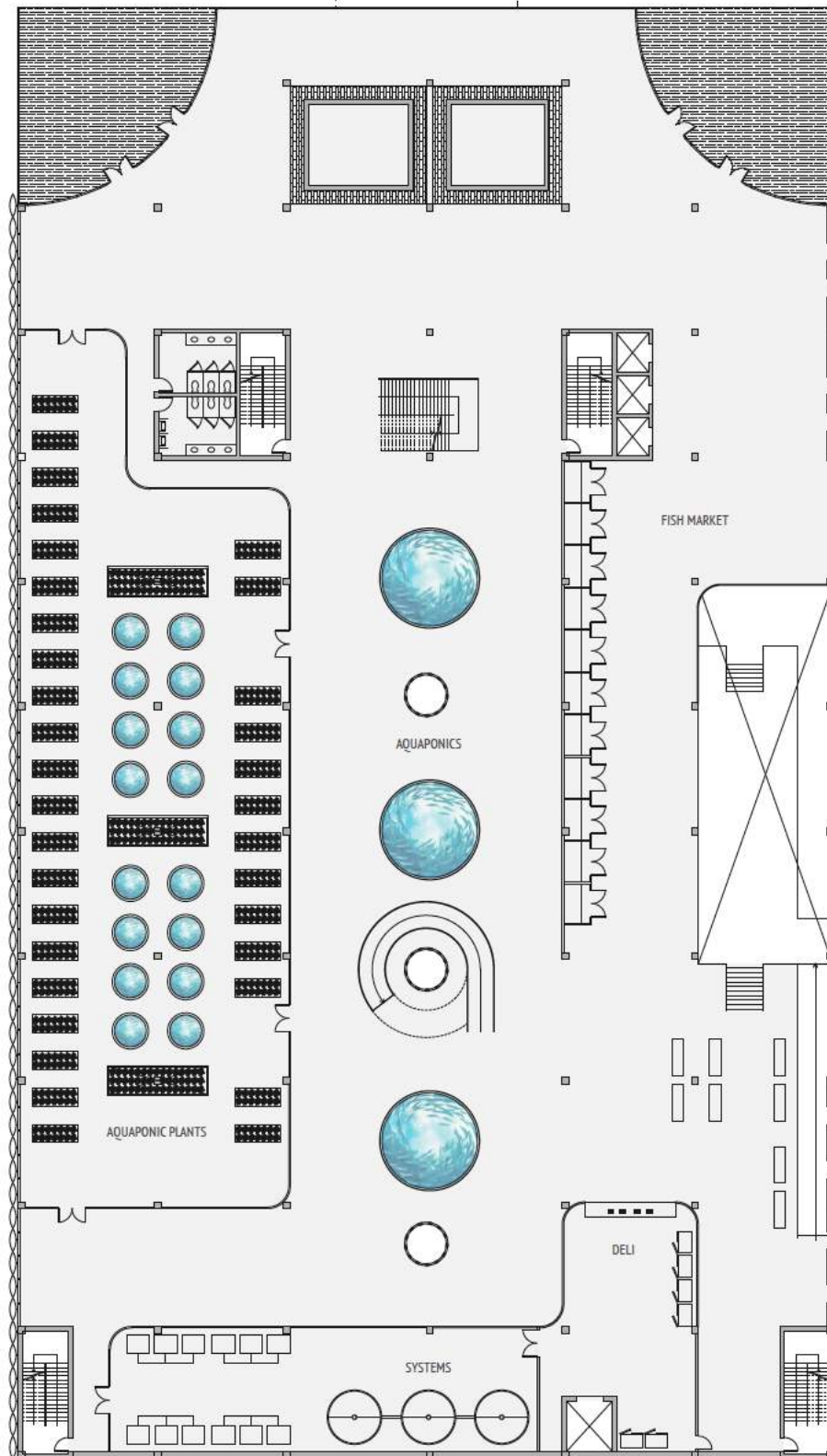


# FIRST FLOOR PLAN

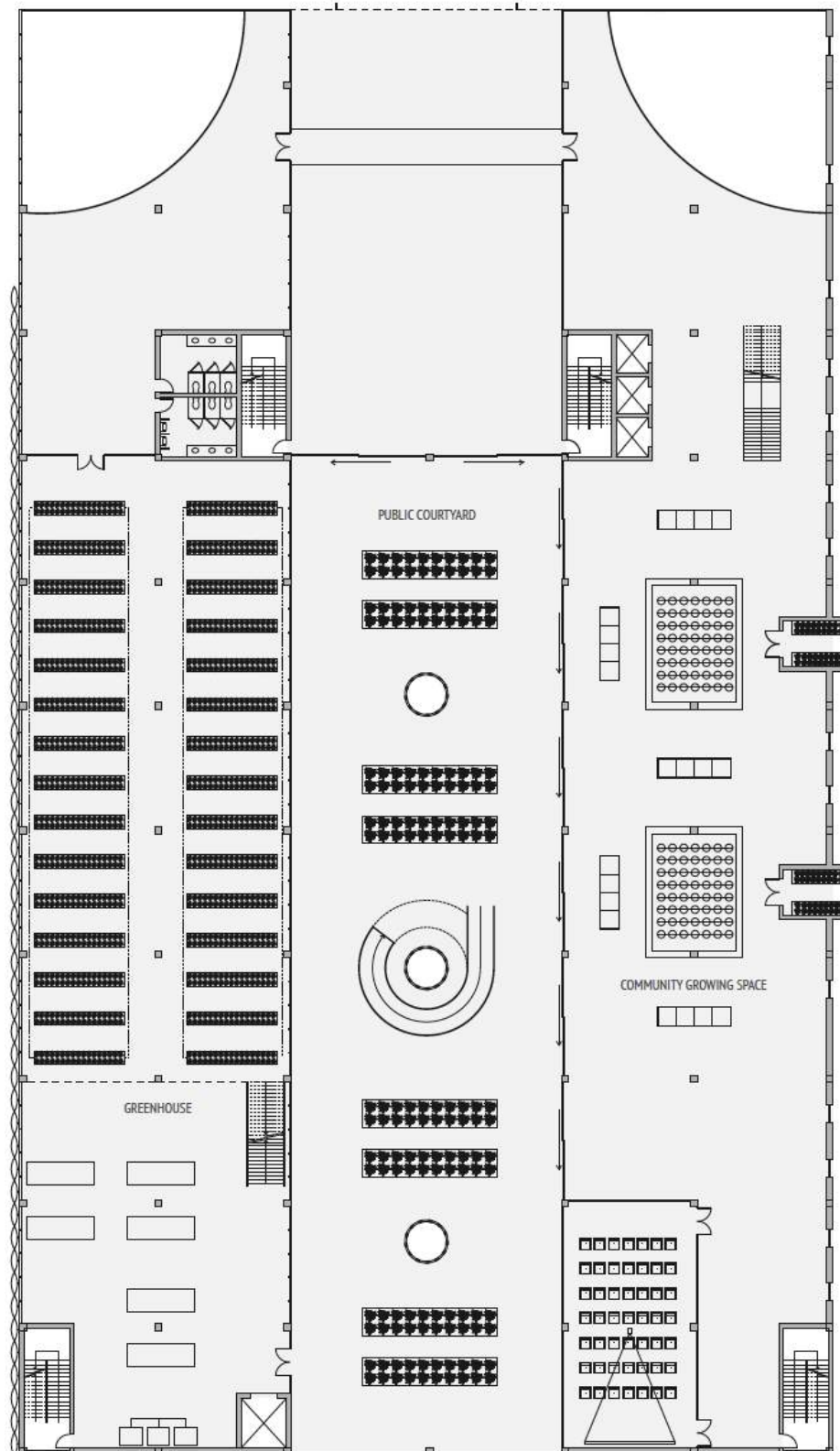




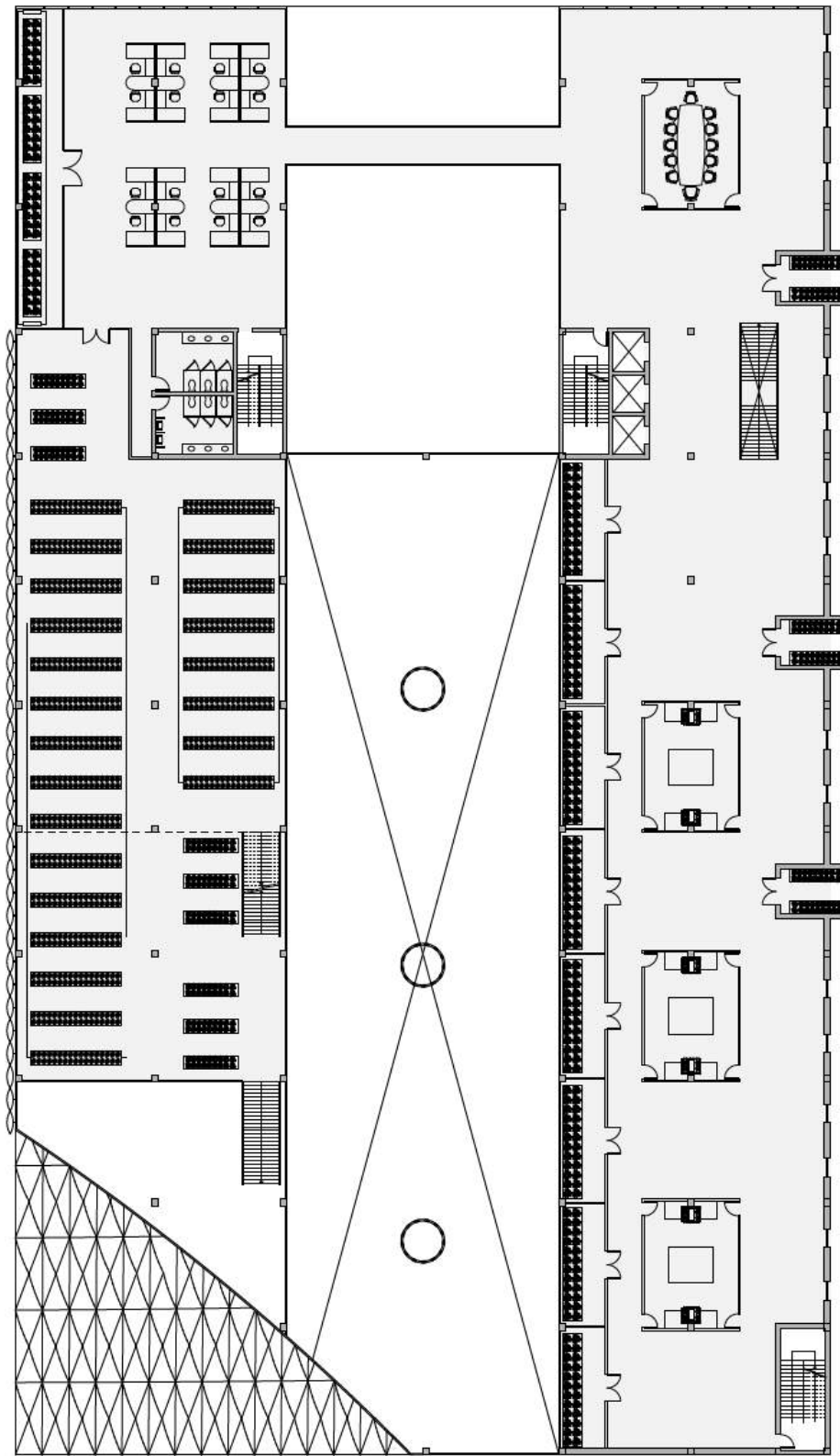
# SECOND FLOOR PLAN



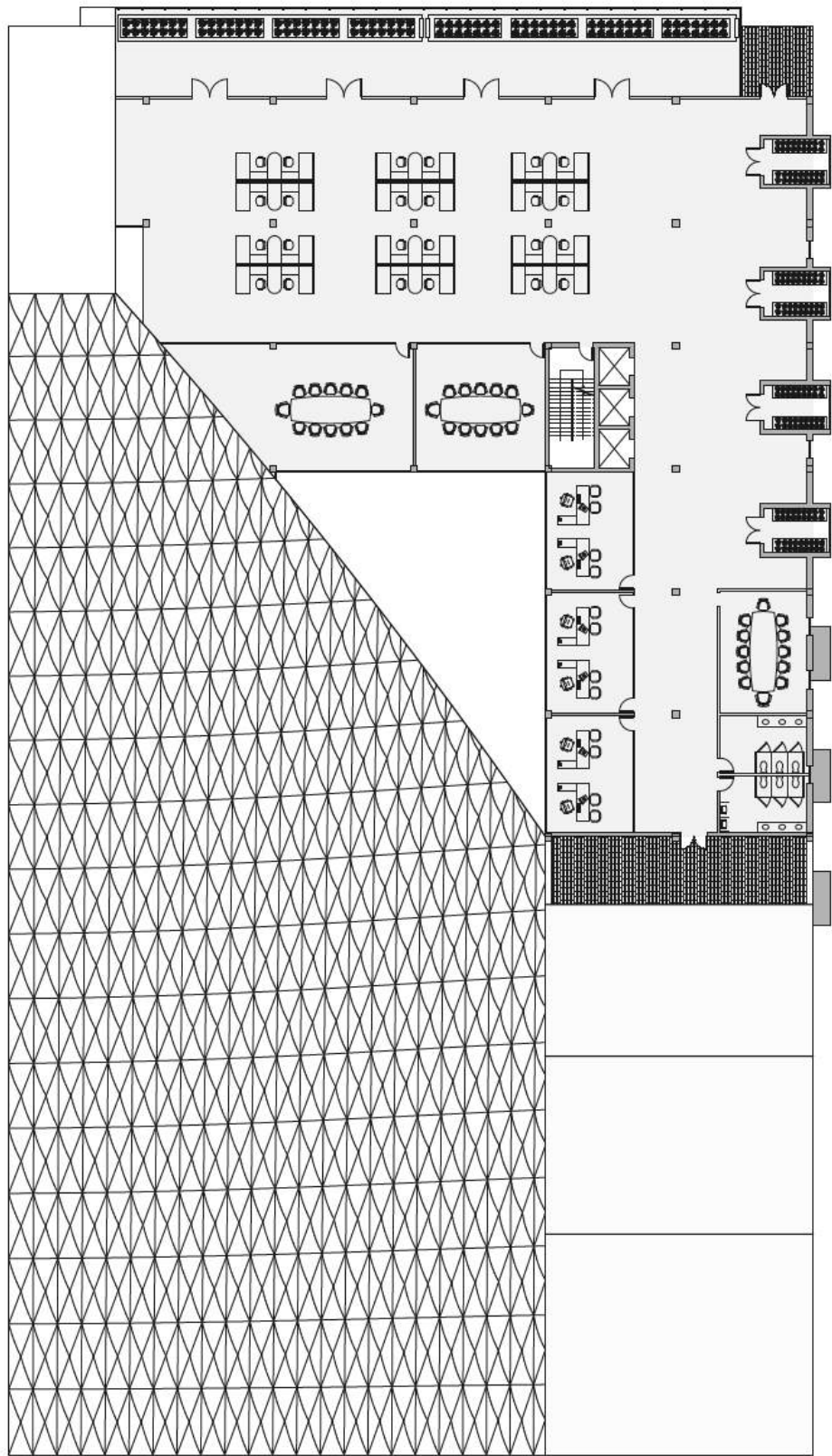
# THIRD FLOOR PLAN



FOURTH PLAN

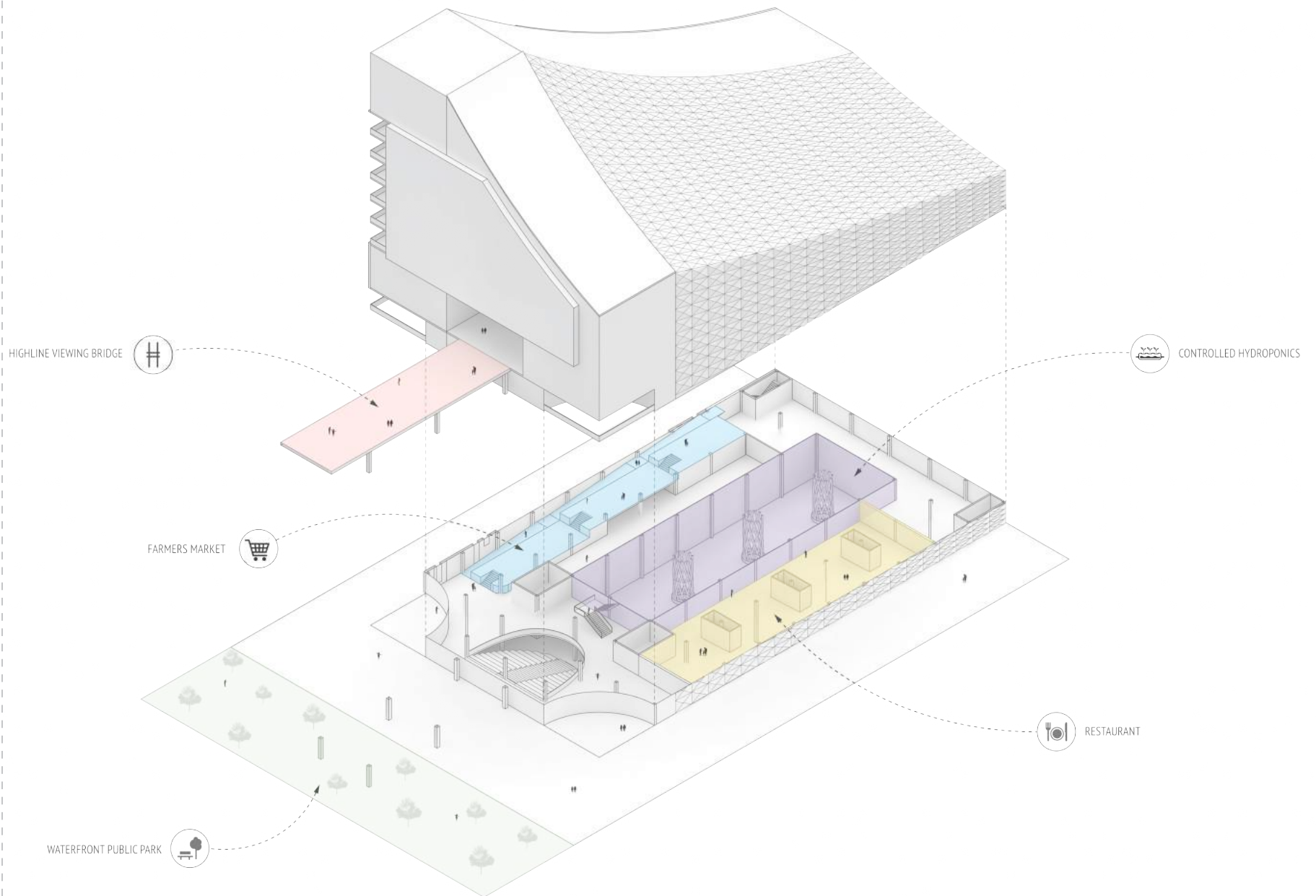


TYPICAL OFFICE FLOOR PLAN

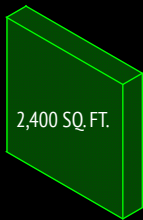




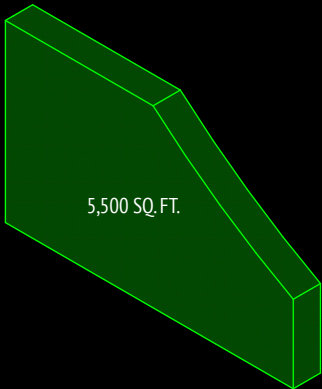
## SOCIAL ACTIVITIES



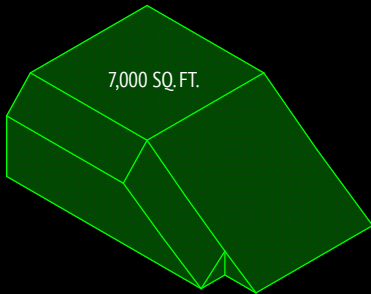
# CROP PRODUCTION CALCULATIONS



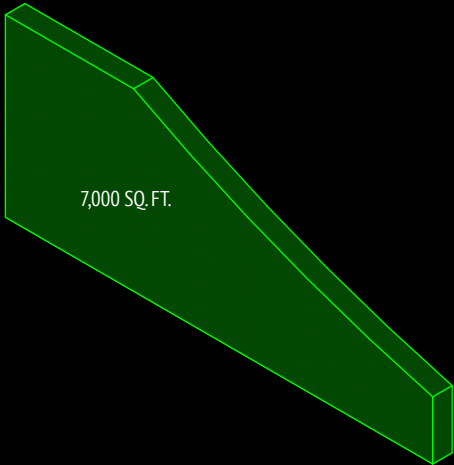
OFFICE VERTICAL CONVEYOR GROW SYSTEM  
2,400 SQ. FT. X 6.6 LBS PER SQ. FT. = UP TO (15,840 LBS)  
OF PRODUCE PER YEAR



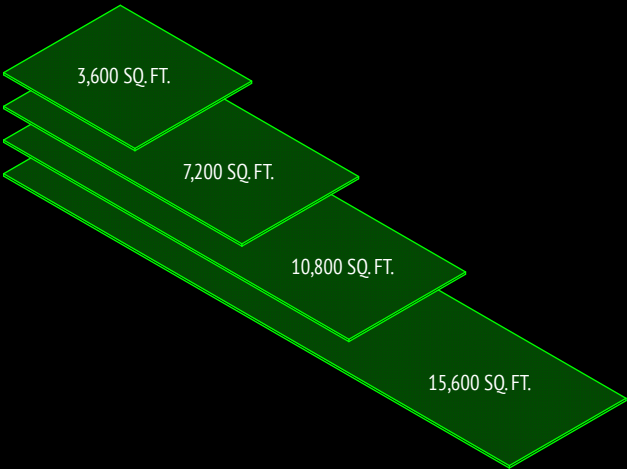
NORTH FACADE HYDROPONIC GROW SYSTEM  
5,500 SQ. FT. X 6.6 LBS PER SQ. FT. = UP TO (36,300 LBS)  
OF PRODUCE PER YEAR



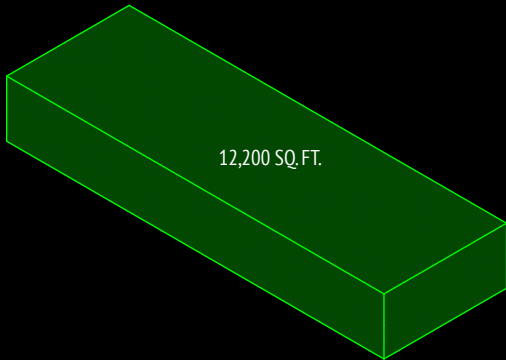
ROOFTOP GREENHOUSE HYDROPONICS  
7,000 SQ. FT. X 6.6 LBS PER SQ. FT. = UP TO (46,200 LBS)  
OF PRODUCE PER YEAR



PUBLIC VERTICAL CONVEYOR GROW SYSTEM  
7,000 SQ. FT. X 6.6 LBS PER SQ. FT. = UP TO (46,200 LBS)  
OF PRODUCE PER YEAR



COMMERCIAL GREENHOUSE HYDROPONICS  
37,200 SQ. FT. X 6.6 LBS PER SQ. FT. X 4 RACKS = UP TO (982,080 LBS)  
OF PRODUCE PER YEAR

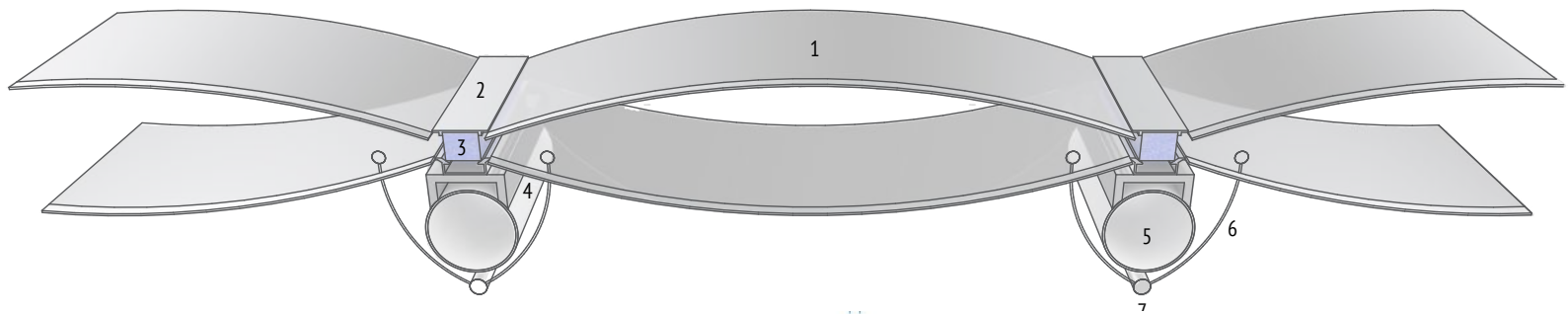


COMMERCIAL AEROPONICS  
12,200 SQ. FT. X 28.5 LBS PER SQ. FT. = UP TO (347,700 LBS)  
OF PRODUCE PER YEAR

\* CALCULATIONS ARE BASED OFF DATA FROM AEROFARMS AND GOTHAM GREENS INC.

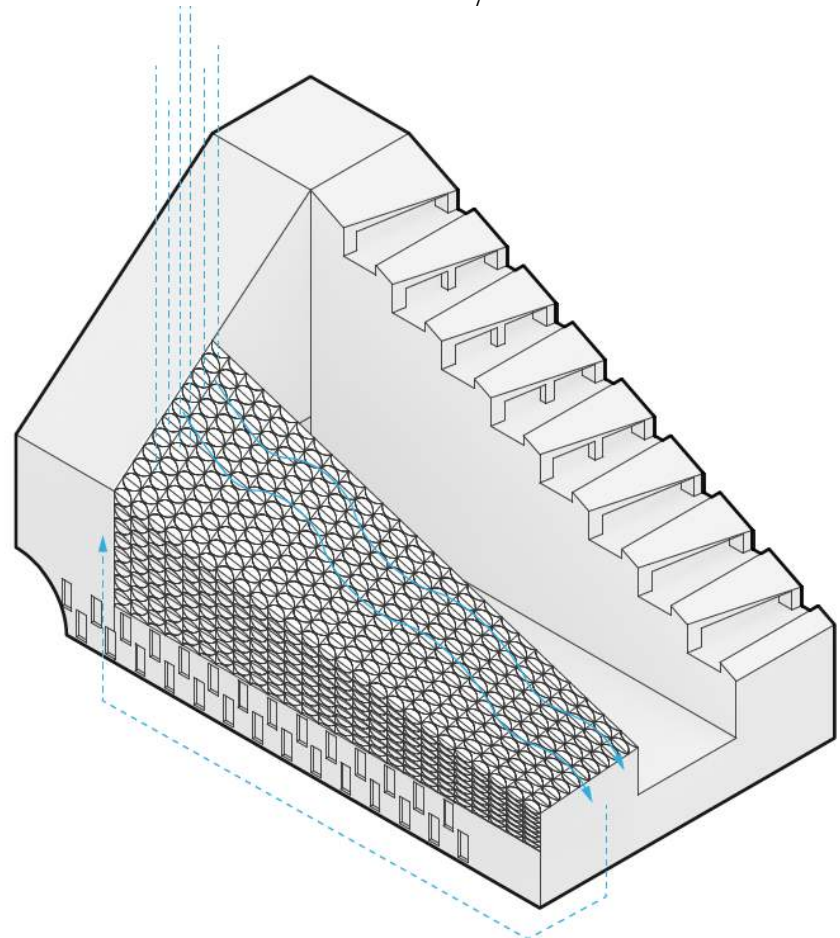
# ETFE ROOF | FACADE SYSTEM

1. ETFE CUSHION
2. EXTRUDED ALUMINUM CLAMPING PLATE
3. THERMAL INSULATION
4. EXTRUDED ALUMINUM RETAINING PROFILE
5. SUPPORTING STRUCTURE
6. PLASTIC AIR SUPPLY TUBE
7. MAIN AIR SUPPLY TUBE

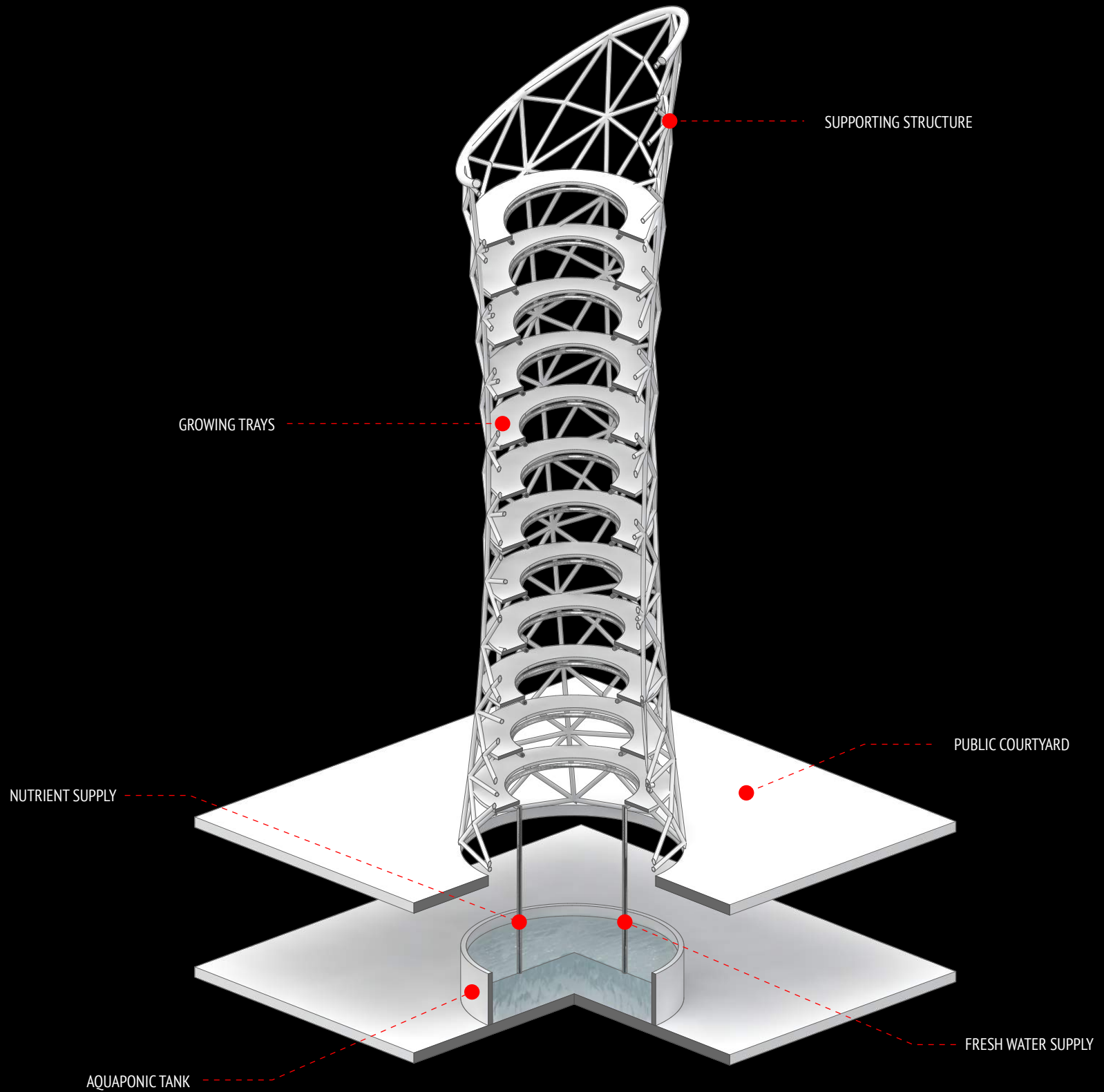


THE ETFE SYSTEM COLLECTS RAIN MORE EFFICIENTLY THAN A STANDARD GREENHOUSE GLASS PANE. THE RAIN IS HARVESTED THROUGH A SERIES OF SMALL GUTTERS WHICH IS THEN FILTERED AND SUPPLIED BACK TO THE HYDROPONIC SYSTEM.

- LIGHT WEIGHT
- HIGH TRANSPARENCY
- HIGH RESISTANCE TO POLLUTION AND CHEMICALS
- 95% LIGHT TRANSMISSION



# RAIN HARVESTING AQUAPONIC FUNNEL





THE PROPOSED CURTAIN WALL SYSTEM  
WILL GIVE BOTH THE RESIDENTS AND  
COMMUNITY DIRECT ACCESS TO FRESH  
HYDROPONIC GREENS.

THE FACADE IS DESIGNED TO MAINTAIN  
A CONSTANT TEMPERATURE THAT IS FIT  
FOR GROWING VARIOUS TYPES OF GREENS.





THE PLANTS ARE GROWN ON A OPERABLE VERTICAL CONVEYOR SYSTEM TO ENSURE AN EVEN DISTRIBUTION OF LIGHT.

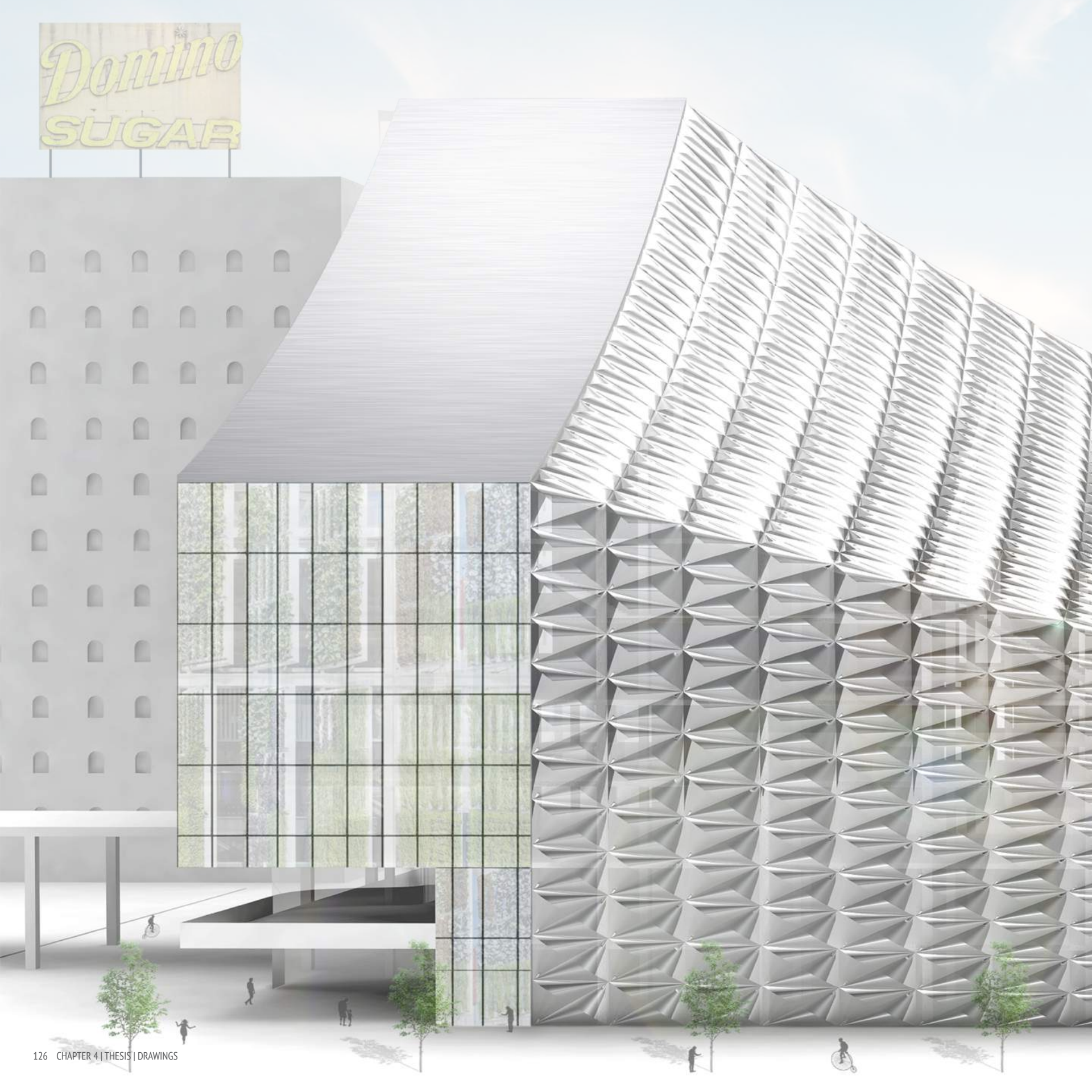
WORKERS CAN HARVEST, RE-PLANT, AND PROVIDE MAINTENANCE TO THE HYDROPONIC SYSTEM.

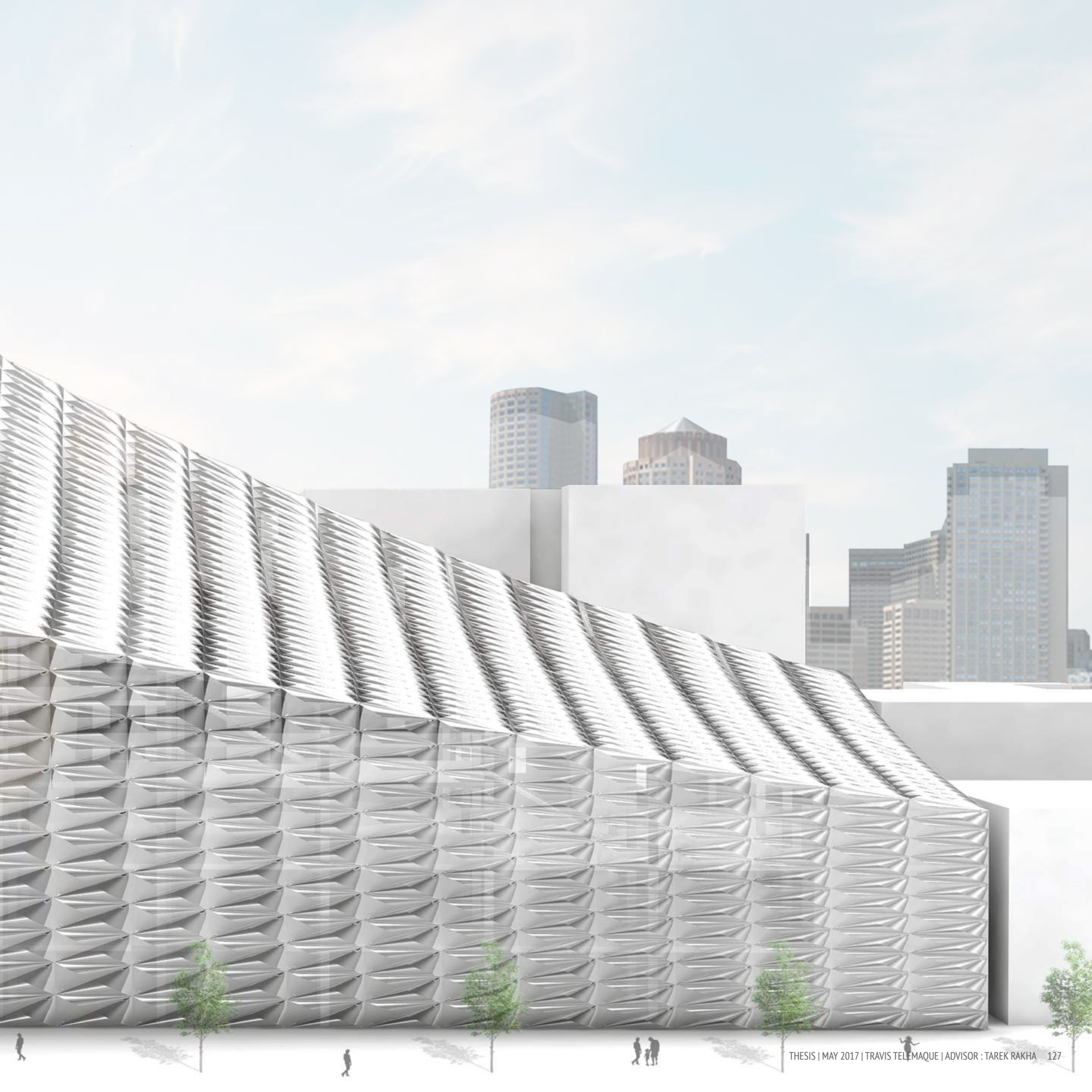




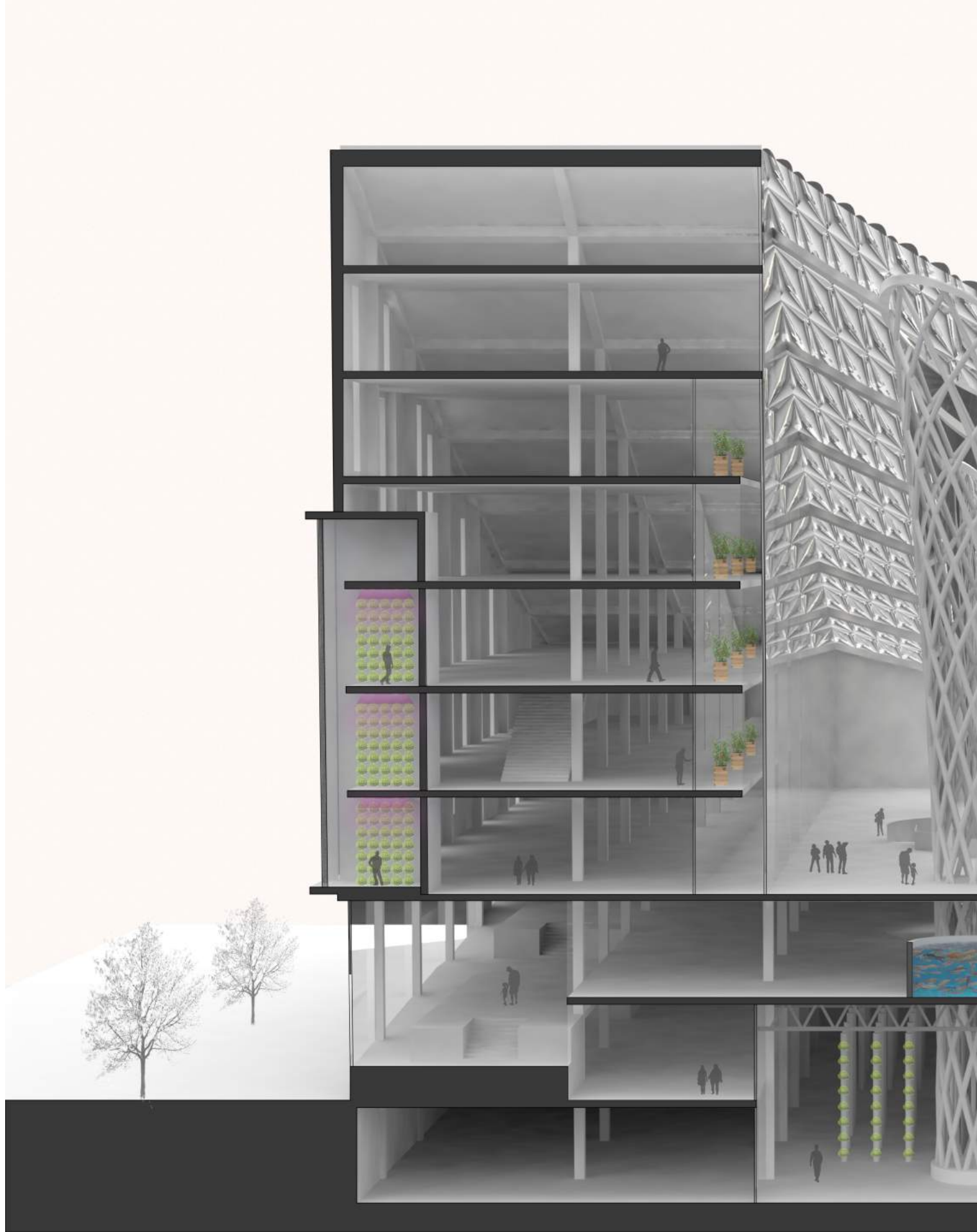


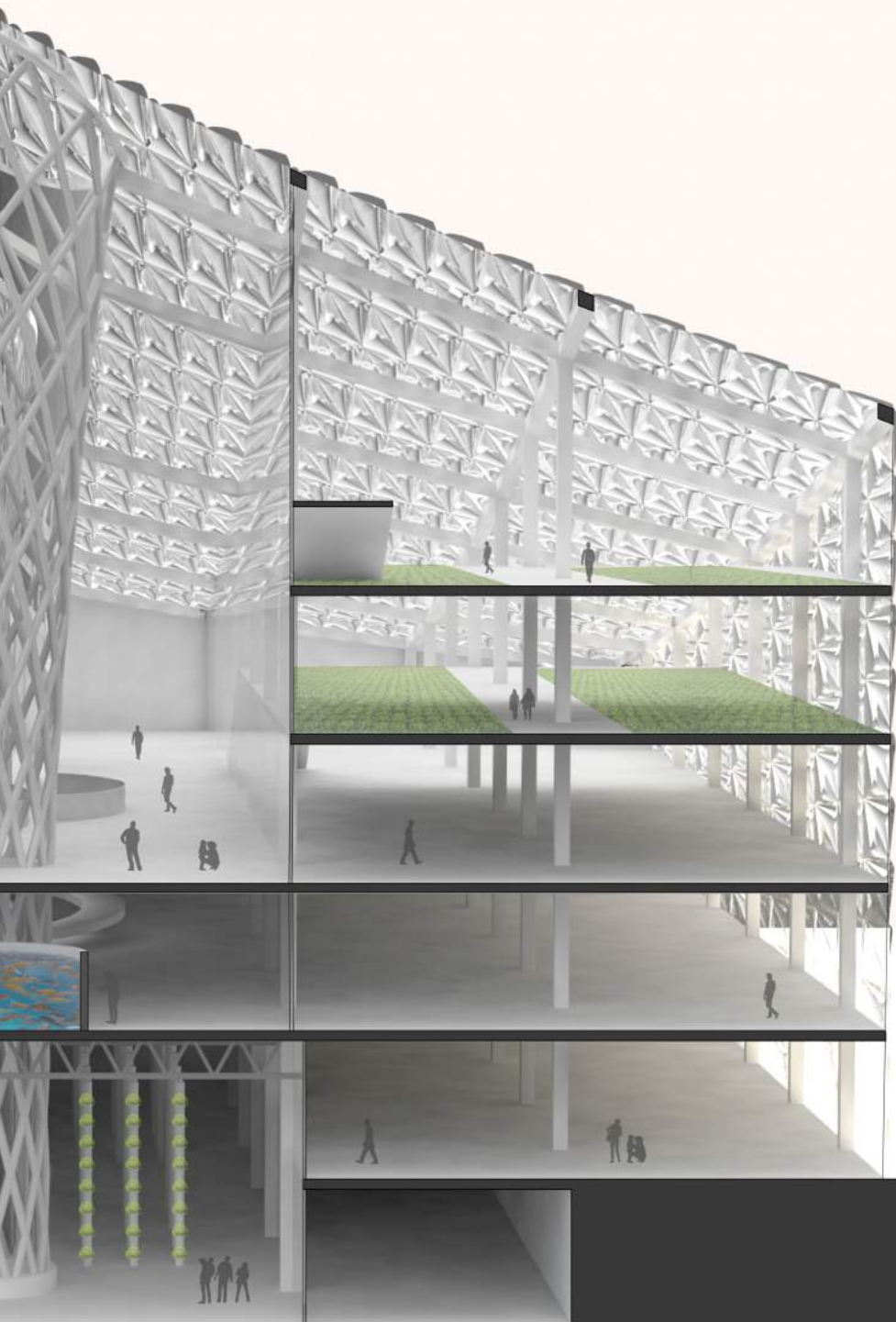








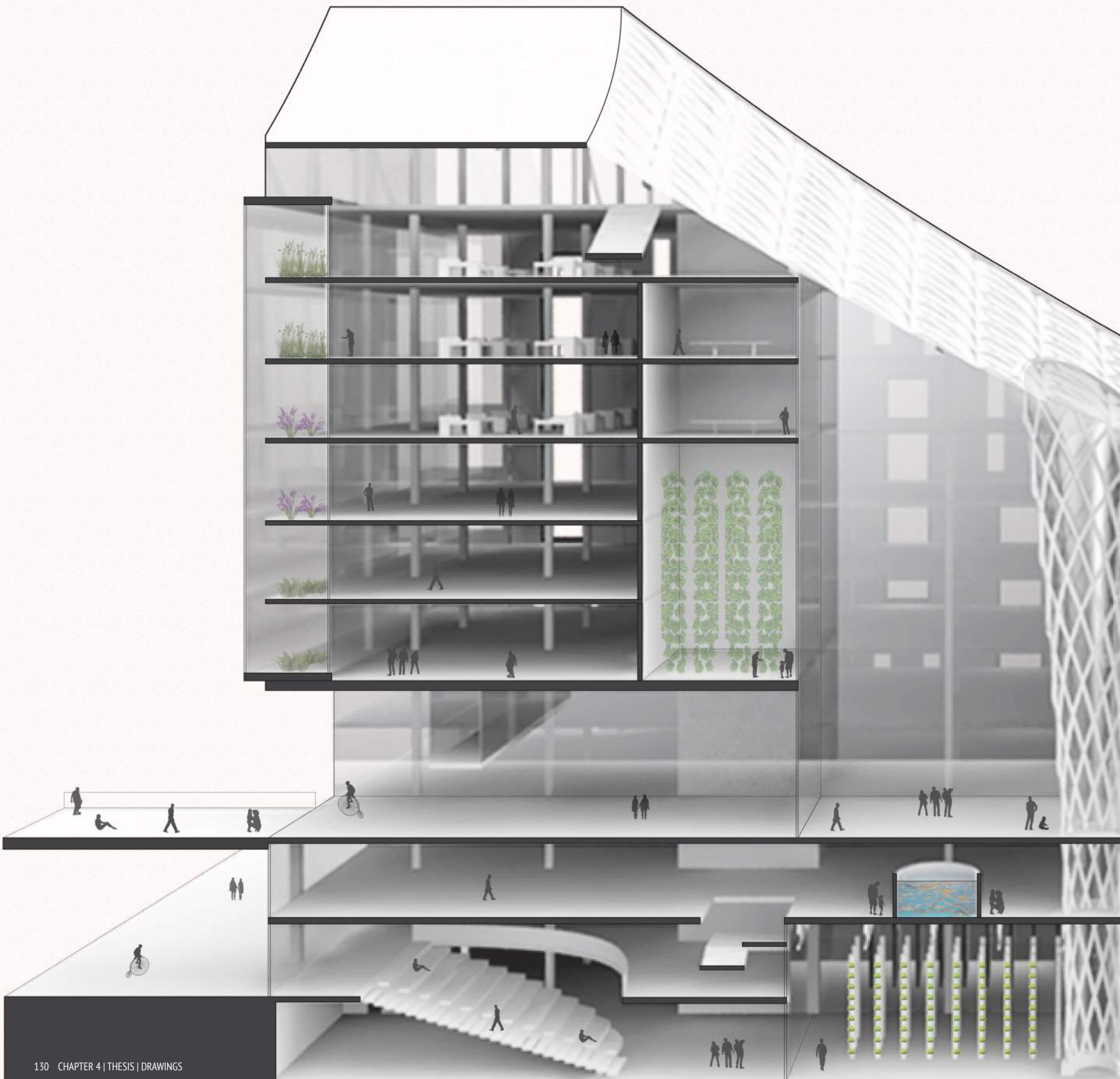


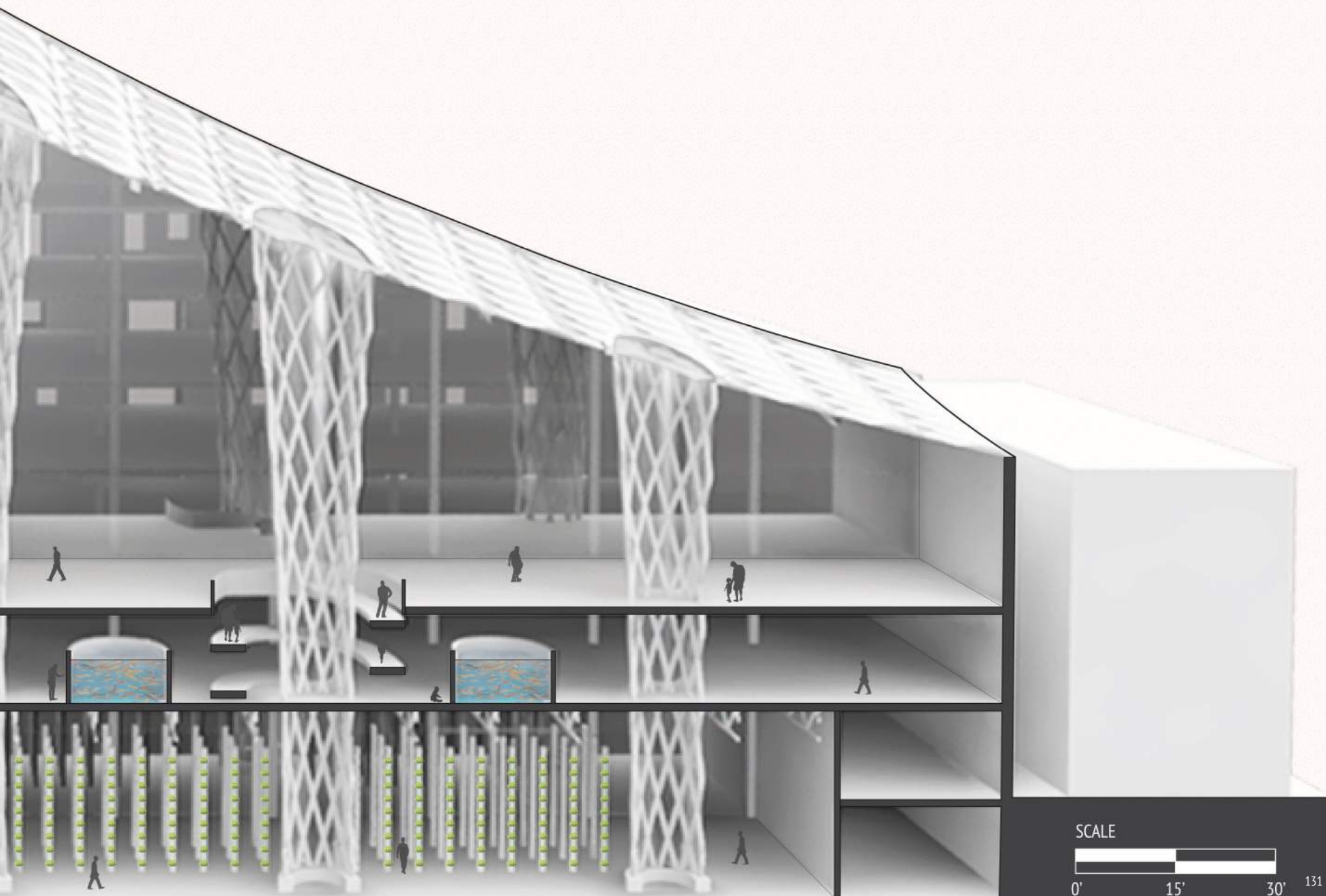


SCALE



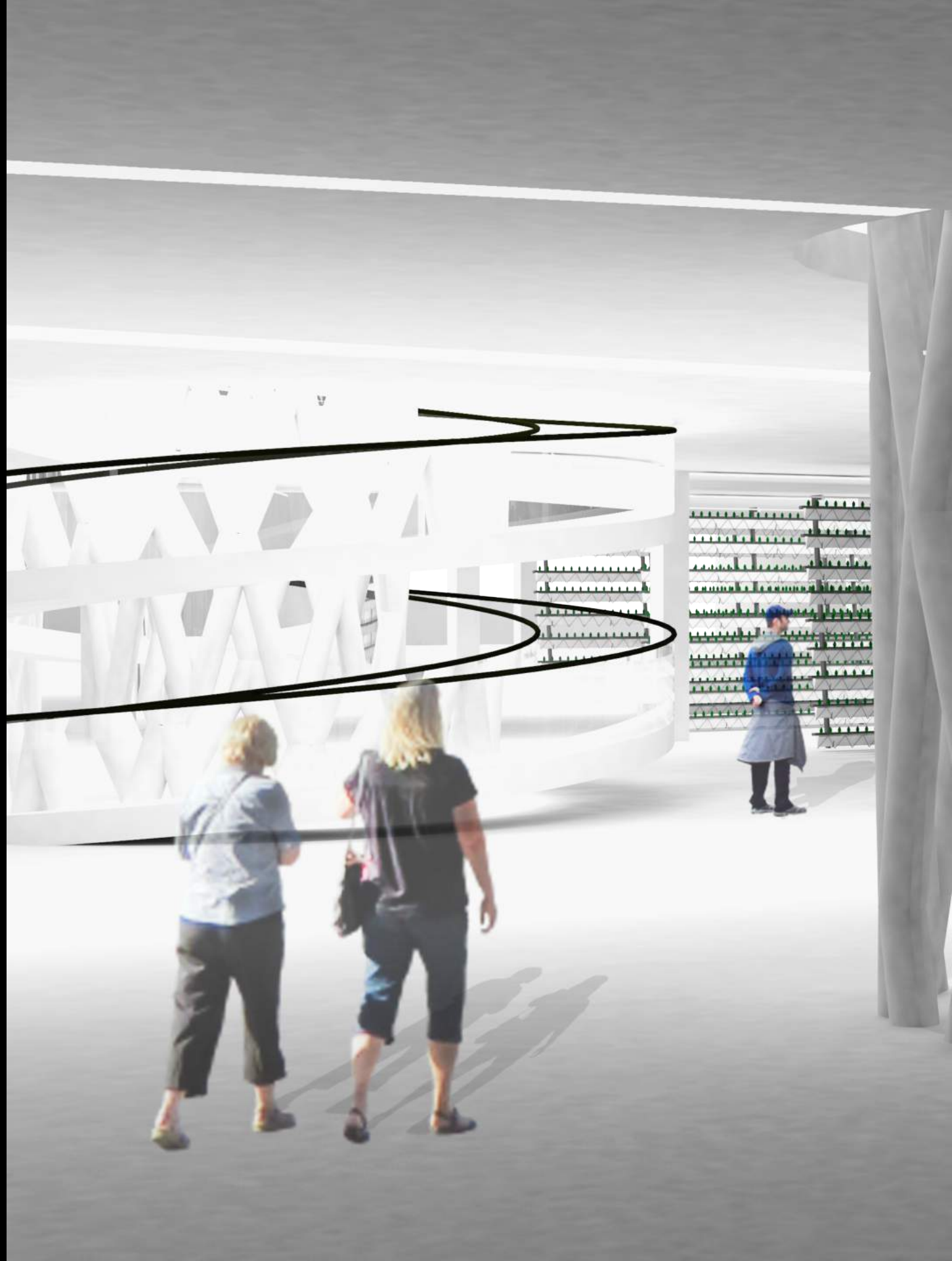




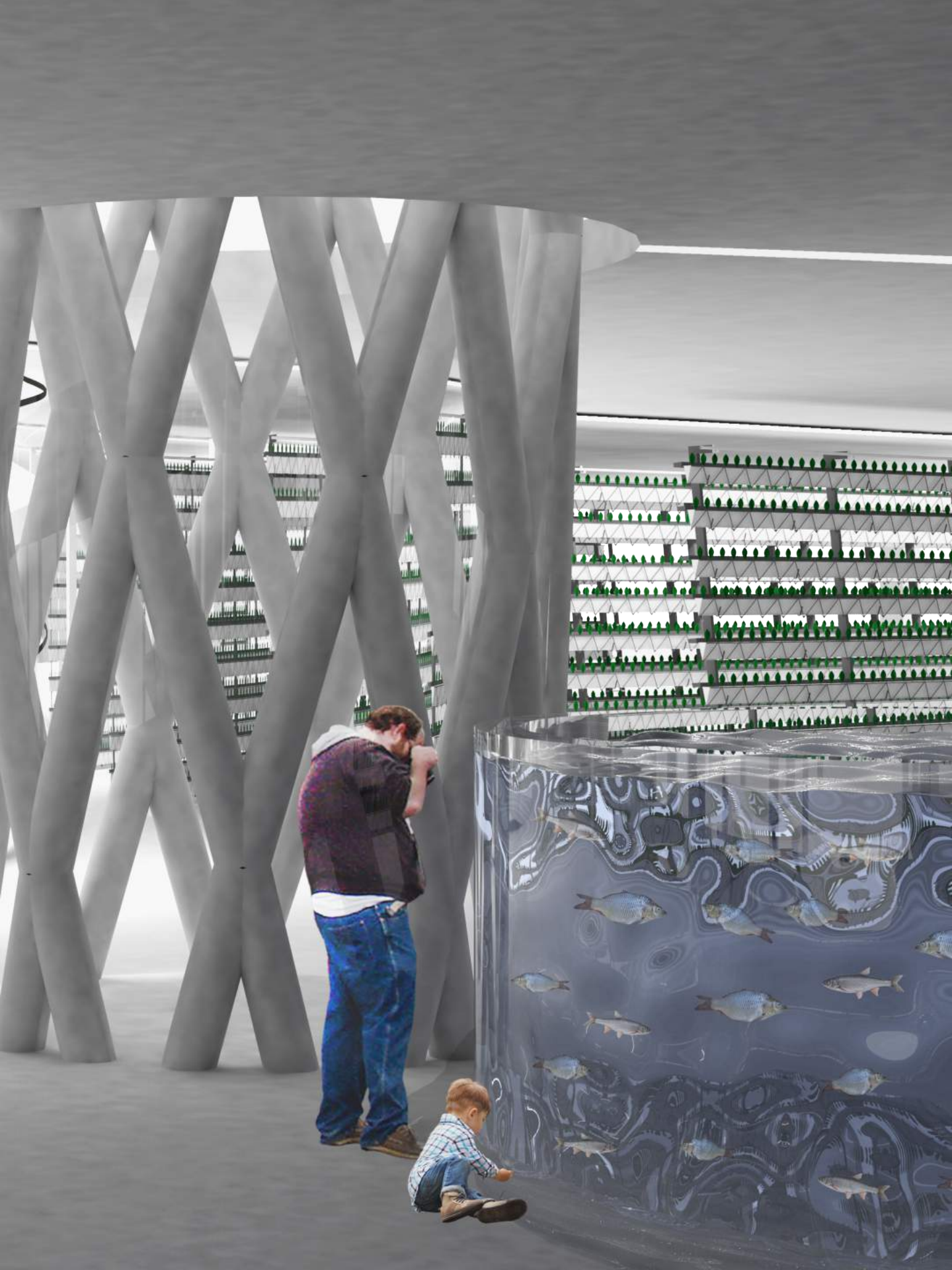


SCALE







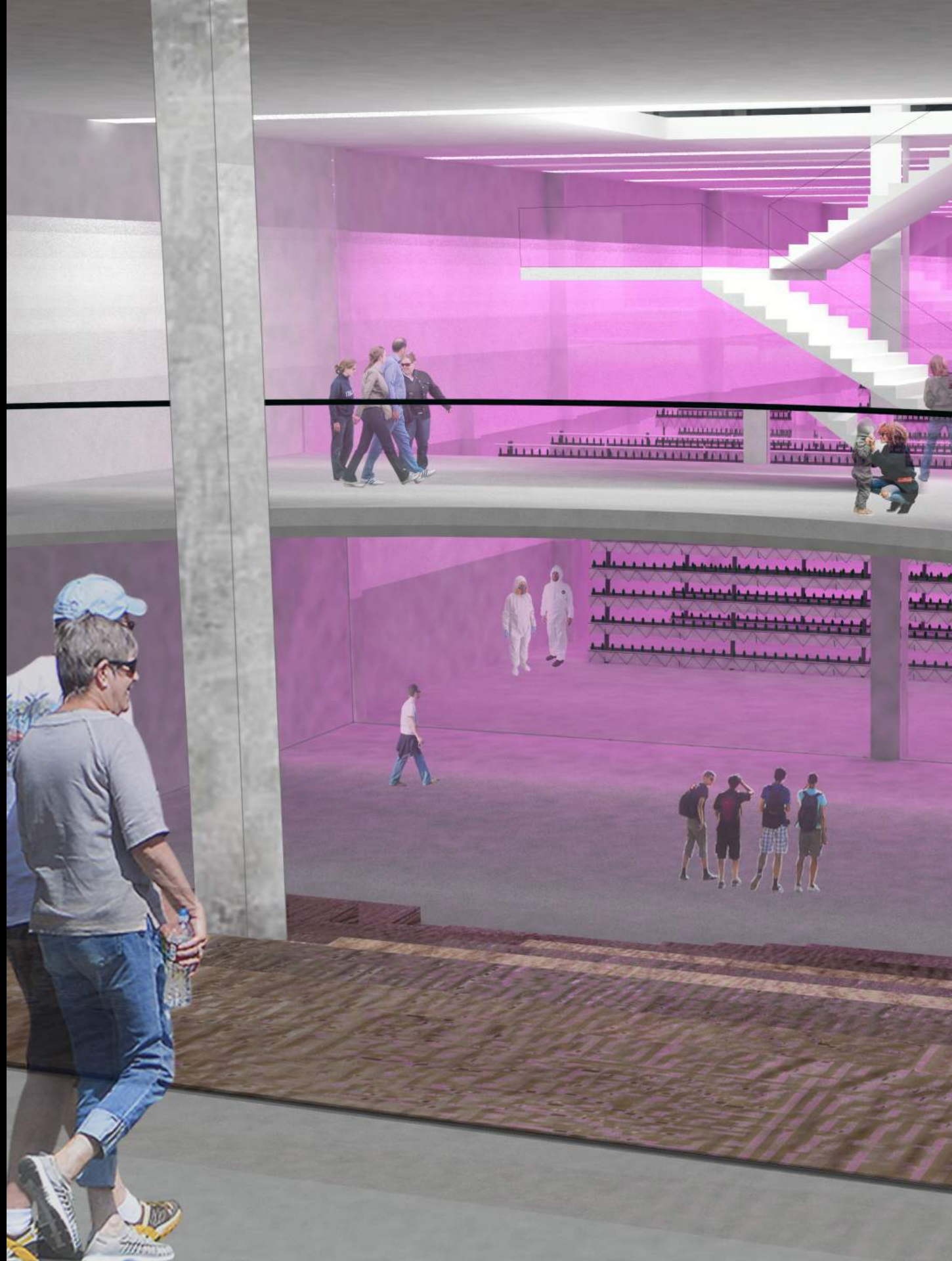






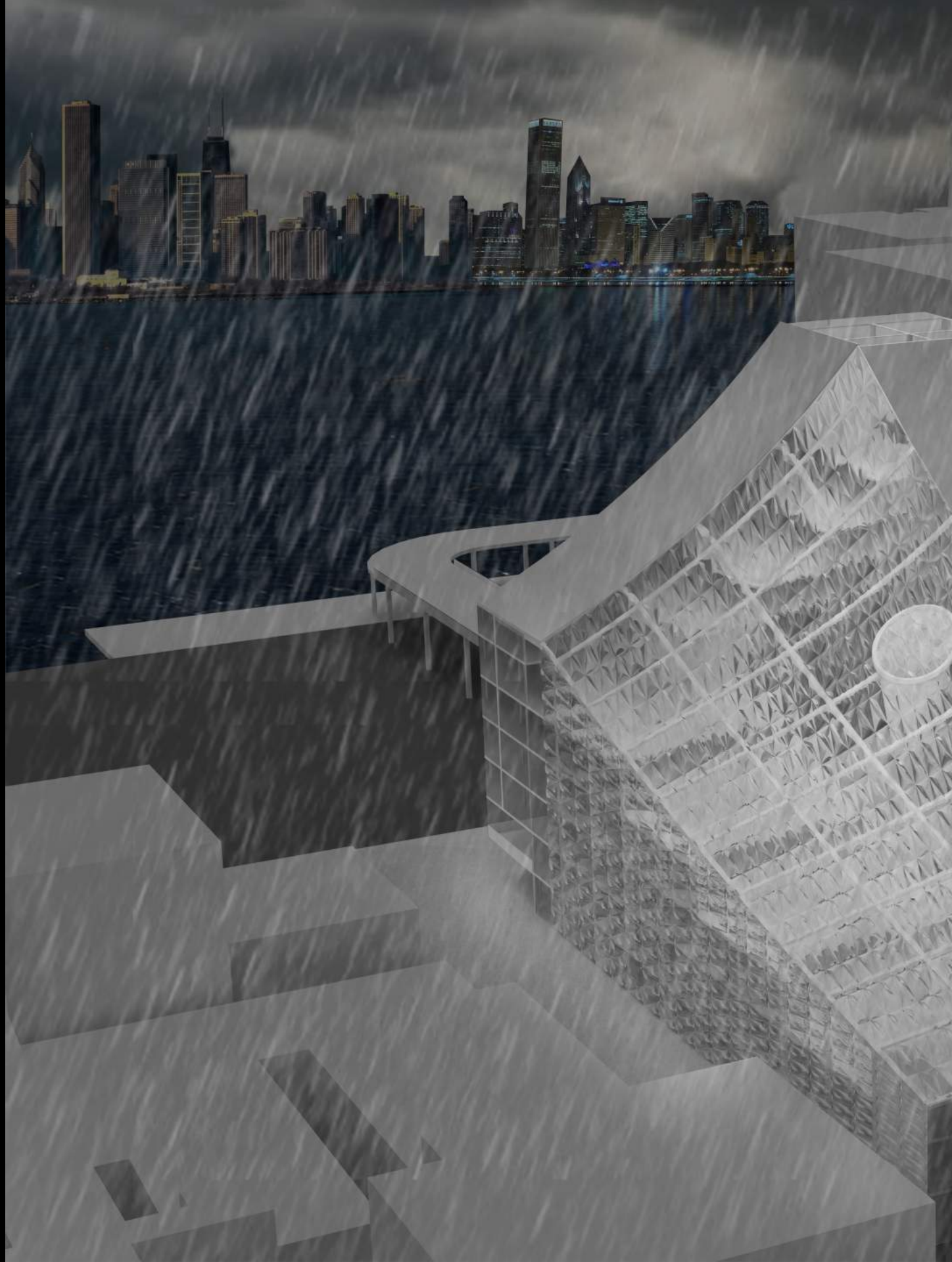


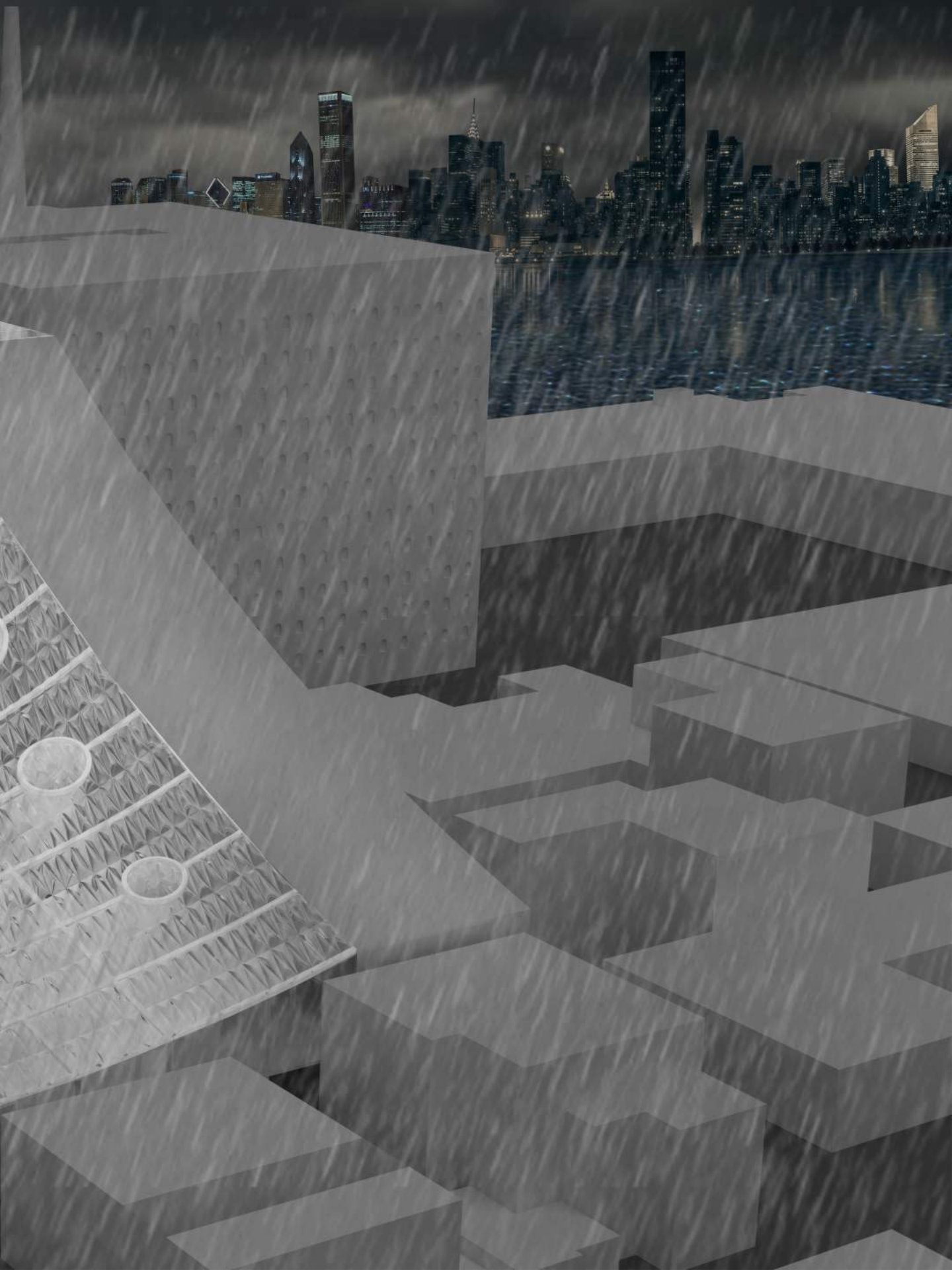












## CONCLUSION

Integrating food production into dense urban areas can reconnect us with food and create more resilient cities. By establishing a sustainable prototype urban farm there is great potential for these structures to germinate across cities. I conclude that building technology and design can adapt to feed the increasing urban populace.

Furthermore, this model for urban farming can be tested in cities with larger populations as well as incorporate residential programs into the design. In the future, buildings will be able to produce and harvest food directly on-site in turn supplying food directly to surrounding neighborhoods.

THANK YOU!



